Diseases of the Eye and Ear

VILAS

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OF THE

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BY

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INTRODUCTORY NOTE.

When the author began his teaching on the diseases of the eye and ear, as part of a regular medical education at the Hahnemann Medical College and Hospital, of Chicago, he found no text-book adapted to the wants of beginners. This volume is the outgrowth of some notes then prepared for the students and printed for the author's convenience as a teacher. They were never designed as, or thought to be, complete, or necessarily original, but were supplemented by clinical teaching, demonstrating the great majority of known diseases, and affording the opportunity to witness operations incidental to all branches of the art. From time to time they have been added to, and, though including but a portion of the diseases familiar to the intelligent specialist, it is believed that the text comprises fully as much as will be mastered in the time now allotted in a general medical education to these subjects. More must be sought in the larger books, with which the profession is abundantly supplied. The words of commendation heretofore received from old students (now practitioners), indicate that this new volume will prove valuable to others who, though they decline all operations, are compelled, from the nature of the diseases, to treat many of them, and to alleviate others, until such time as the patients can be safely sent away. Should this prove to be true, the aim of the author will be accomplished.

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Diseases of the Eye and Ear.

THE OPHTHALMIC DISEASES.

SECTION ONE.

To practically **diagnosticate** the diseases of the eye is essential to their successful treatment. There are certain leading symptoms which may indicate the disease or give a clue to its origin.

A patient consulting a physician about his eyes will generally dwell upon defective sight alone, some external inflammatory or irritative symptom, some disfigurement, or of pain only, etc.

When there are symptoms of **external irritation** or inflammation, if there is also watering, photophobia, or swelling of the lids, with or without redness of the eye, and defective sight, carefully look for foreign bodies, such as bits of coal, etc., in the cornea or folds of transmission of the conjunctiva. If any are found on or imbedded in the former, a spud may be necessary to remove them; if on the latter a touch of the index finger, or a bit of twisted paper, will remove them. Examine also the lids for ophthalmia tarsi, styes, irregular growth of the lashes, meibomian and other tumors. Eczematous patches are often found on the lids in phlyctenular troubles, which may also extend to the malar region of the face and nose, and not infrequently to the ears. Crusts may also be found on the lids, exposing, on removal, an inflamed edge of the lids (blepharitis or blepharadenitis). Examine also the inner surface of the lower lids; if there is thickening or redness, evert and examine the upper lid for granular disease.

To evert the upper lid (eversion is not required for the lower one), seize hold of the lashes with the thumb and finger and draw it out from the globe, then place the tip of the forefinger of the other hand about its center, to act as a fulcrum, and, telling the patient to look down, quickly turn the lid up and over. A lid elevator is of no value in looking at conjunctival troubles, but it is useful in

those of a corneal nature. Sometimes it may be found necessary to give chloroform or ether to quiet children in corneal or iritic trouble.

Examine the surface of the eyeball carefully as to the degree and character of the congestion, whether local or general, affecting the exposed or only the covered parts, due to superficial, tortuous, bright red vessels, as found in conjunctivitis, or to deeper, straighter, pink or purplish vessels suggesting ulcers of the cornea, or iritis, or cyclitis. Spots or pustules, with local congestion, may be present, indicating, perhaps, phlyctenular ophthalmia. The cornea may show one or more spots or patches of opacity due to injuries, foreign bodies or ulcers of the cornea, or be hazy all over as in keratitis, or show a number of minute dots at its lower part, indicating keratitis punctata. The chief symptom may be persistent watering of one eye, as in lachrymal obstruction, etc., or slight soreness, blinking, a little watery or gummy discharge, and inability to use the eyes long, or to bear bright light or strong winds, as is seen in mucocele, hypermetropia, myopia, and asthenopia; or discharge with congestion of the eye and lids, indicating conjunctivitis; or spasmodic closure of the lids, and photophobia, as in the corneal diseases.

Defective sight may be especially complained of, with more or less inflammatory signs, and with or without severe pain. In which case examine the cornea for ulcers and other haziness; the pupil for size, mobility, and clearness, and the iris for color and general appearance, in order to avoid overlooking iritis, or glaucoma. Take the tension and ascertain roughly the condition of the visual field and note accurately the near and distant sight.

Should the complaint be of defective sight in one or both eyes, without other symptoms, it may indicate an error of refraction or accommodation, or opacity of some of the media, or disease of the retina, choroid, or optic nerve. Hence ascertain whether one or both eyes are affected; the duration of the defect, and under what circumstances as regards the distance of objects and brightness of light it is most observed. A defect of one eye often remains undiscovered for years. If the failure of sight is related to bad health or to pain in the head, albumenuric retinitis, optic neuritis, or atrophy may be thought of. Take the near and distant vision, and examine the transparency of the cornea, of the lens for cataract, and of the vitreous; also note the color and appearance of the irides, and the size, shape and mobility of the pupils, so as not to overlook iritis, and try the tension of the globe for glaucoma. If the media are clear, the iris and pupil healthy, and the ophthalmoscopic appearances normal, examine the

refraction and accommodation for hypermetropia, myopia, presbyopia and paralysis of the accommodation. If an opacity of the lens or vitreous is suspected, or if the defect of sight is not corrected by glasses, it is usually best at once to make a thorough ophthalmoscopic examination, and desirable to examine the fundus carefully, by the erect image, in all doubtful cases. If the disc appears markedly oval, either before or after the use of atropine, astigmatism is to be suspected. As to atropine, it is, as a rule, far better to use it to the extent of dilating the pupil, than by examining with a small pupil to run the risk of overlooking small but important changes in the lens, vitreous or fundus. The necessity for its use will depend very much on the skill of the observer, and on how much time can be spent over the case; for the larger the pupil the more easily and quickly is the fundus explored. When the sight is fair, the patient should always be warned that the atropine will dilate the pupil and make the sight dim for a day or two, or even much longer. Hydrobromate of homatropine, one grain to the ounce of distilled water, is superior to atropia sulphate for such purpose, as the pupil contracts in much less time. Cocaine sometimes works well and the effect speedily passes away. When there are changes in the optic disc or reason to suspect disease of the optic nerve, the color perception should be tested. Further, the complaint being of double vision, ascertain by closing one eye whether it is binocular or monocular; monocular diplopia or polyopia is rare, and is recognized by the persistence of the symptoms when one eye is closed.

When there is a squint or some other **disfigurement**, or inability to open the lids, ptosis or blepharospasm should be thought of. Inability to close them may be caused by paralysis of the facial nerve; defective movement of the globe in one or the other direction by muscular paralysis; prominence of one or both eyes may suggest Basedow's or Graves' disease. Swollen, but not inflamed lids may be caused by emphysema or orbital tumors. In myopia the eyes are often prominent, and if the myopia is one-sided, this appearance may be unsymmetrical.

When **pain** is the only or chief symptom dwelt on, note whether it is referred to the eyeball, or to the forehead or temple, etc.; whether periodic and not related to the use of the eyes, as in neuralgia, or irregular in onset and related to the general health, or distinctly related to the use of the eyes, as in myopia, hypermetropia, and asthenopia. In all these cases the sight should be tested, and a careful ophthalmoscopic examination made.

Nasal diseases are often important factors in originating and perpetuating certain forms of eye disease, and when present must be cured as a preliminary stage to successful treatment of the eye.

The treatment of eye disease demands the use of solutions prepared from various alkaloids. First among such, and without which the treatment of eye diseases would at times be extremely hazardous, is **atropia sulphate**, commonly called **atropine.** But atropine is insoluble in water, and hence the former is made by treating it with sulphuric acid. When rightly prepared atropia sulphate is wholly devoid of any acid effect in the eye, no tingling or smarting effect being observed. Unfavorable results may be caused by bad preparations, and their results attributed to the atropia rather than its improper preparation.

Pure, neutral atropia sulphate, when rightly used, will diminish the intra-ocular tension, draw back the iris and prevent adhesions to the anterior capsule of the lens; prevent adhesions to the posterior layer of the cornea, tear away adhesions when formed; prevent prolapse of the iris, and not infrequently restore it when prolapsed; compel it to rest; and diminish its congestion. It will also diminish the congestion of the ciliary body; compel the ciliary muscle to rest; lessen ciliary neuralgia, and act as a local anæsthetic during its passage through the cornea, allaying irritation.

Irritation of the conjunctiva with an eczematous condition of the lids may be caused by its use, however, and its effect should be carefully observed when the posterior portion of the uveal tract is affected, and in persons over forty years of age. Acute glaucoma may be hastened in eyes already attacked, and there is danger that its prolonged use may cause detachment of the retina in predisposing cases. In addition paralysis of the fibers of the iris may be caused by the prolonged use of a strong solution, and slightly unpleasant effects by the solution running from the conjunctival sac into the throat through the lachrymal canaliculi may occur; or it may even be absorbed to this extent.

Its strength may be varied according to the necessities of the case. One-half a grain of atropia sulphate to an ounce of distilled water, is sufficient to dilate the pupil for examination of a healthy eye, but when inflammation is present, solutions of two to four grains to the ounce are required—one drop from a drop-tube to be placed in the eye, the lower lid being slightly everted.

The antidote to atropine may be a strong decoction of cŏffee, which in cases requiring a more powerful antidote is best alternated

with hot vinegar. When an immediate antidote is required, however, a hypodermic injection of morphia is essential, and excells all others.

The four-grain solution may be used in all cases where the rapid and full mydriatic action of the drug is required. The ciliary muscle and iris do not usually thoroughly recover from the effect of its use for about ten days. The two-grain solution may be used when it is desired to keep the pupil partially dilated for a long time, as in immature nuclear cataract. A single drop two or three times a week will generally suffice. Solutions will keep for an indefinite time; the sediment which often forms does not impair their efficiency.

Homatropine is a substitute for atropine and is sometimes valuable in that its mydriatic effects pass off quickly in comparison. A solution of two grains to the ounce of distilled water may be used with value in examinations, as the pupil will usually return to its normal size in about twelve hours.

Duboisine, the alkaloid of duboisa myoporoides, is similar in its effects to atropine, but more powerful, and as it often causes rather alarming symptoms, care should be exercised in its use. Preferably in the form of the sulphate, its strength should not be equal to that of atropia, one-half the quantity being usually sufficient.

Hyoscyamine, the alkaloid obtained from hyoscyamus, may be used when atropine is not well borne, and fully considering the various statements, it would seem that under its use the pupil will dilate more rapidly, remain longer dilated, and of not less maximum degree, than when atropine is used. Unlike duboisine, its effects are not distressing at times, but it does not keep as well.

Pilocarpine, and usually the hydrochlorate, is the alkaloid obtained from jaborandi. It causes profuse salivation and sweating and is used to quite an extent in optic nerve troubles.

Eserine, the alkaloid of calabar bean, has been justly greatly praised for its effects on the eye, especially in corneal troubles. It may be used of about the same strengths as atropine. The salicylate of physostigmine, now officinal in the new United States Pharmacopœia, is another preparation of value from the bean. The great value of eserine, aside from its use in corneal troubles, is found in that it is the only myositic on which dependence can be placed. While antagonistic to atropine mydriasis, and displacing it and substituting its myositic effect, eserine can not long hold the ascendency, but gives way after a short time, and the mydriasis reappears. A solution of the alcoholic extract of the bean (four grains to the ounce of distilled water) or a little of the extract itself may sometimes, with advantage, be substituted for the alkaloid.

Daturine, the alkaloid of datura stramonium, is also useful, especially when atropine can not be borne. A solution of four grains to the ounce of distilled water is usually the strength required.

Cocaine is valuable both as a mydriatic and as an anæsthetic. Some twenty minutes after instillation, dilatation of the pupil begins, but never progresses to the maximum degree, and may be readily overcome by instilling a drop of eserine. It will not appear again, even though more cocaine is used afterward.

Our literature is already laden with cases where harm has been done by its use. By the experienced only should it be freely used in eye diseases, and its effects in combination with other drugs, as atropine, should be carefully studied in individual cases.

The temporary anæmia produced by the drug is of great value in operating, as it renders conjunctival operations bloodless, or nearly so. The value of this alone in strabismus operations is evident. In **extracting foreign bodies** from the cornea and other external portions of the eyeball, its value can hardly be over-stated. When the tissue is fully under its influence, deep indentations can be made on the cornea, spuds and finger readily used, and any foreign body removed. Thus these painful little operations, often not to be done without chloroform heretofore, become a matter of a few moments' painless procedure. A solution of two grains to the ounce of distilled water is sufficient for all ordinary eye operations.

Care should be taken to avoid spurious or **imitation alkaloids** of all these substances, of which there are many in the market. All the mydriatics and myositics may be obtained in the form of small gelatine discs of known strength, which are sometimes more convenient than the solutions.

The best solutions for **antisepsis** are made from powerful poisons, mercuric bichloride, or carbolic acid. The former may be used in solutions varying from one to five thousand to one to two thousand; the latter, usually, one to one hundred to five to one hundred. Boracic acid (five to one hundred) is valuable, as are others.

For **disinfectants** there are many preparations but nothing better than Platt's Chlorides. This mixture may be readily burned, when desirable, by dissolving three drachms of potassa nitrate in eight ounces of the undiluted chlorides. In this thin strips of muslin should be saturated, thoroughly dried, and then burned in different parts of the room. Bromo-chloralum, Labarraque's Solution, and many other forms of disinfectants are also easily available.

Very many of the remedies used locally are prepared for sale in

the form of **cerates**, as belladonna, rhus toxicodendron, etc. Others may be ordered made when desired.

Bandages for the eyes should be of thin flannel. A linen or knitted cotton bandage, about ten inches long, with four tails of tape, or a loop of tape embracing the back of the head (Liebreich's bandage) is very convenient. The protective bandage consists of a roller of thin flannel about one to one and one-quarter inches wide, and four to six feet long. Placing one end a little in front of the auricle opposite to the eye to be protected, the bandage is brought across the forehead and around the head to the point of beginning, and thence down over the eye (over which and to fill up even with the brow and face, cotton or lint has been placed upon a piece of cloth about two inches square, oiled to prevent adhesion to the skin of the lid and face) around under the opposite auricle, and back to the beginning, where it may be fastened and held in place by a safety pin. The pressure bandage is similar, but of finer flannel and longer. It is more carefully adjusted, all wrinkles being smoothed out so as to firmly bind on the forehead and head. When so arranged, a firm but gentle pressure can be made and strongly secured.

It requires a little practice to get them properly adjusted, but nothing can exceed their efficiency for the purposes intended. When absolute exclusion of light is desired, it is best to use a bandage made of a double fold of some thin black material. Fine old linen is better than lint for placing next the skin in dressing after operations.

The hermetical bandage is for use where it is desirable to seal up an eye to protect it from contagion, as in purulent conjunctivitis. It is made by covering the eye with a piece of soft linen, over which is placed a pad of charpie, or picked lint, over the charpie a piece of oiled silk, over the silk a piece of linen, and the whole then coated with collodion, and fastened by it to the skin at the edges of the bandage.

Where this form is not advisable, take two pieces of India-rubber plaster, one four inches, the other four and a half inches, square. Cut a round hole in the center of each, and stick them together with a watch crystal inserted between and covering the hole. Then fasten with collodion, leaving an opening below for ventilation.

Shades. Should a shade be required, it may be made of thin cardboard covered with some dark material, or of stout, dark blue paper, like that used for making grocers' sugar-bags. Shades of black plaited straw are also very light and convenient. To be effectual, they should extend to the temple on each side, so as to exclude

all side light. An excellent one, with a spring extending half way around the head to hold the shade in place, is for sale at the opticians' shops.

SECTION TWO.

The Ophthalmoscope is the only instrument by which a thorough examination of the eye, without and within, can be made. In many respects its use is like that of the otoscope, or laryngoscope; it would be even more like these instruments, but for the fact that its successful use requires the harmonious adjustment of two complicated and separate dioptric systems, the eye of the examined and that of the examiner. Such is the case with no other diagnostic instrument; hence the difficulty so often met with by the novice.

This fact, thoroughly comprehended, will serve to eliminate all the discouraging elements, and enable anyone with a small amount of labor, to grasp the wonders which the ophthalmoscope reveals.

Previous to 1851, when the discovery of the principles of this instrument was published to the profession, nothing beyond a few scattered observations had been evolved in the way of solving the problem of the illumination of the fundus of the eye. This had been due to the fact that it was believed that the choroid absorbed the rays of light reaching the fundus, and that none were returned. This error being practically refuted, a new era dawned in the progress of ophthalmic exploration. Nearly all diseases of the eye posterior to the lens were also either unknown, classed under amaurosis, or the subjects of mistaken conjecture. By this one invention, the innermost and hitherto unseen recesses of the eye were lighted up, and unknown diseases placed within the range of vision.

As the use of the instrument began to be known and appreciated in eye diseases, it was but natural that the phenomena here observed should in time be associated with those occurring in more remote parts of the system. The results obtained have been most gratifying; for the ophthalmoscopic appearances of the base of the eye (fundus oculi) are now recognized as important factors in the diagnosis of many diseases of the general system.

The eye itself is an optical instrument in which the refractive media combined are about equal to a convex lens of one inch focus.

By means of these media, images of external objects are formed upon the retina in an inverted position. In a normal and healthy eye, images of objects at various distances are distinctly focused upon the retina, although it is evident such would not be the case without some change in the refractive power of the media. A change takes place which is called the accommodation of the eye.

By its accommodative power, the eye adjusts itself involuntarily for perception of objects at distances varying from a few inches to about eighteen to twenty feet, which is regarded as an infinite distance, and usually spoken of as infinity. Divergent rays from near objects and parallel rays from distant objects, are just as accurately focused by a simple change in the focal distance of the lens, in a manner as yet in some obscurity, different theories being advanced and seemingly well sustained by their authors, in conjunction with other changes not necessary to now consider.

As has been stated, it was formerly believed that rays of light entering the eye reached the fundus and were there absorbed by the pigment layer of the choroid; hence no rays were reflected outward through the pupil to convey to the eye of the observer an image of the interior. This belief seemed confirmed by the black appearance of the pupil. The reason for such a mistake was due to the fact that rays of light projected into the eye are returned to the point whence they came. By means of the refractive media the ingoing and outcoming rays form a cone of light whose base is at the pupil, and whose apex is at the source of illumination. This cone of light is nowhere wider than the pupil, and diminishes in width as the distance from the pupil increases. It is therefore evident that any attempt of the observer to place the head so as to receive the emergent rays within the pupil, would cut off the whole source of illumination; for the width between the observer's pupil and the temporal side of the head is much greater than that of the cone of light at any point.

The emergent rays from the fundus are generally slightly convergent. They may be rendered parallel by either placing behind the mirror a concave lens, with which all instruments are supplied, or by requiring the patient to look at a distant object, the latter way being used as experience permits.

By looking at a distant object, the eye is accommodated for parallel incident rays, hence the emergent rays being equally refracted become parallel. Parallel rays are better adapted to the formation of distinct images upon the retina of the observer.

Ordinarily the concave mirror is preferred to the plane. By con-

centrating the incident rays, it not only reflects more light into the eye, but as the rays are convergent when they enter, they are brought to a focus before reaching the retina, and as a result cross each other and form circles of dispersion. A larger portion of the fundus is thereby lighted up at one time.

There are many modifications of the ophthalmoscope devised by ingenious brains to develop and clear up the seeming difficulties, but all involve the same principle. An examination of their mechanism with a careful study of their advantages will render the modes of use quite plain, and familiarize the examiner with the details of the practical principles involved.

A skillful operator can obtain in most eyes a very good idea of the condition of the fundus without the use of a mydriatic. It is usually quite unnecessary in cases where it is only desired to examine the optic disc and its immediate vicinity. In such cases care should be taken to use a moderate degree of illumination only; a bright light causes contraction of the pupil, and dazzles the eye.

To make a **practical use of the ophthalmoscope,** the room should be darkened and the patient seated erect near a table, resting the arm upon the table, or with the back firmly supported by a chair. A light with a clear, steady flame should be stationed at one side, and about a foot behind the patient's head; it is better, but not essential, that it be upon the side of the head corresponding to the eye to be examined. Any good light will answer, and it is unnecessary to have any special standard, though what is known as an oculist's bracket, with a double-armed, adjustable swinging movement, is very convenient.

The observer should now be seated opposite the patient, their eyes on a level or nearly so, and this position is best attained by having one or each seated upon a revolving adjustable chair. The observer may use either eye for examination of one of the patient's eyes, but it is preferable to use the one corresponding to the one to be examined—that is, the right for the right, and the left for the left.

Direct method.—Let the ophthalmoscope be taken in the right hand, if about to use the right eye, delicately holding it by the handle near its free end, and lightly resting the upper portion of the rim of the mirror against the brow while the eye is applied to the sight-hole. The companion eye should now be momentarily closed to be sure the observer is looking through the sight-hole, and then both eyes should be kept open. The mirror must be so inclined to the light that the reflection will fall directly upon the patient's pupil.

Having thus far followed directions, the pupil of a healthy eye will present a reddish appearance from the bright reflection of the fundus. The patient should now be directed to look slightly inward and fix the gaze upon some distant object over the observer's right shoulder, and about on a level with the tip of the ear. If the left eye is to be examined, the patient should look over the observer's left shoulder in the same manner.

As soon as the eye is turned inward, the red appearance of the pupil changes to a light yellow, seemingly white in persons of dark, swarthy complexions. This change is caused by the optic disc coming into view. The disc is usually the starting point in exploring the surrounding parts of the fundus, but before proceeding to a closer examination it is well to first ascertain from a distance with the ophthalmoscope whether the red reflection of the fundus is clear. Some slight opacity of the lens or vitreous may thus be detected, and explain an appearance which would perhaps otherwise be referred to the fundus.

Next the observer should ascertain the refraction by observing if the retinal vessels can be seen clearly from a distance. If the vessels are distinctly visible at a distance, the eye is either myopic or hypermetropic: the first if the vessels move in an opposite direction from the observer's head when moved sideways, and the second if they move in the same direction. In emmetropic eyes, the details of the fundus can be distinctly seen at a distance of two or three inches from the patient's eye, while in the other conditions, myopia and hypermetropia, the mirror must be held at a distance of about fourteen to sixteen inches. However, if an appropriate correcting lens is held behind the mirror, the emergent rays from the fundus of the patient's eye may be rendered parallel, and a clear image obtained at a short distance, the same as in emmetropia. A concave correcting lens will be needed for examination of myopic eyes, and a convex for hypermetropic eyes. The power of this correcting lens will, of course, depend upon the degree of ametropia to be overcome. Furthermore, as there are usually unconscious efforts of accommodation in either the eye of the observer or of the observed, a ten or twelve inches concave correcting lens may be found useful in examining an emmetropic eye. These unconscious efforts in the eye of the observer may be also overcome by experience, those of the observed by the use of a mydriatic.

This way, called the direct method, shows only a very limited field at a time. Seemingly the simpler, it requires much careful and patient practice for its mastery.

The **indirect method** of examination requires the use of one

of the large convex lenses in conjunction with the mirror. The lens of two and one-half or three inches focal distance is most commonly used. Following the manner laid down in the direct method as far as necessary, the observer then takes such a lens between the thumb and forefinger of the unoccupied hand and brings it up before the observed eye from the temporal side, resting the extended little finger on a spot near the temple to steady the hand. Not moving the little finger from its resting place, nor the ophthalmoscope from the brow, the observer tells the patient to look slightly inward and observe some distant object, as in the direct method, and at the same time adjusts the lens to its focal distance. The reflected rays from the mirror now pass through the interposed lens and enter the pupil. The mirror is held at some distance in all the conditions of refraction; for by the use of this lens the distinctions of myopia and hypermetropia and involuntary accommodation in the observed eye may be practically disregarded so far as searching for a distinct image is concerned. This image is actually on the observer's side of the lens, inverted and in the air; and the observer's eye need only to be moved a little nearer in myopia, and a little farther away in hypermetropia, in order to see it well. If the optic disc is only partly in view, it can be brought fully under observation by the observer moving either the head or the object lens. The image moves in a direction opposite to the movement of the head, and in the same direction as the movement of the lens.

An apt observer will soon become able to easily move the head in various directions, all the while keeping the light accurately focused upon the pupil. Not only should one become adept in this, but also in focusing a clear and sharply defined image of each detail. The head of the observer must be at such a distance from the aerial image as is sufficient for the perception of small objects. The image may be enlarged with advantage by using a convex lens of about ten inches focus behind the mirror.

The lateral, or **oblique illumination** may be employed with much benefit for parts of the eye as far back as the posterior lens capsule. It is much used in conjunction with the ophthalmoscope, hence its consideration now.

In this method, the lamp is placed in advance and to one side of the head of the patient and the observer sits in front or stands behind the observed. Either of the large lenses usually accompanying the ophthalmoscope may be used to concentrate the light from the lamp upon the observed eye, and the other lens used as a magnifying glass, is desirable, through which the observer looks at the parts under exam-

ination. Diffused daylight may also be employed. By successive movements of the observed eye, occasionally varying the position of the lens, the cornea, crystalline lens and iris may each be thoroughly examined.

All changes of the crystalline lens and parts anterior to it may be seen in their true colors, but with the ophthalmoscope all opacities appear black. Foreign bodies, nebulæ, synechiæ, etc., invisible to the eye alone, may be easily defined by this method. The minutest facet or indenture on the cornea may also be detected by placing the patient with the face toward a window through which strong daylight is falling. Any such irregularity will at once become apparent by the dispersion of the rays from it, looking on a smaller scale not unlike a mirror indented and cracked by a sharp blow which causes the glass to splinter. It is best seen by looking in a direction nearly at a right angle to the course of the incident rays of light.

As in other branches of physical diagnosis, a familiarity with the appearances in health is necessary to the detection of disease, so it is with the eye; the condition of the parts in health must be the standard by which to estimate the nature and extent of disease.

As already mentioned, the reflection from the **fundus** is reddish, but its tint varies greatly in different individuals. Among dark races the fundus of the eye is of a brownish-gray color, while among the European races it approximates a crimson-orange. The variations of color and tint depend upon the amount and color of the pigment filling the cells of the choroid, and obscuring to a greater or lesser degree the choroidal vessels.

In people of very light complexion, the fundus is often found to be of a bright scarlet color. Such is the case in the Swede, while in the Italian, or the Spaniard, the color is proportionately darker.

Examination of the fundus can hardly be regarded as complete without the employment of both the direct and the indirect methods of exploration. The first shows only a very limited portion at a time, but this portion is highly magnified and in its true color. The second shows a large field at a time, and enables the observer to note the relation of the parts more accurately; but the color of the image is not a true representation of the color of the object, nor is the image so highly magnified as by the direct method.

The disc or **papilla,** is the point where the optic nerve terminates or expands into the retina. It is usually round, or slightly oval with its long diameter vertical. Its color varies, and the darker the eye, the whiter the **disc** appears by contrast with the surrounding

choroid. The color is generally pink or rosy, and varies from this to a steel-gray. In very dark eyes the disc appears white.

The color is derived from three sources,—the white of the connective tissue, the red of the capillaries, and the bluish-gray of the nerve tubules. The circumference of the disc is well defined; it is enclosed first, by the white ring of the sclerotic, and second, by the darker choroidal border.

The sclerotic ring which encloses the nerve appears as a slender zone of white, usually most marked at the outer side of the disc. Sometimes only a portion of this ring can be seen, or it may even be entirely obscured. Outside of the sclerotic ring, the border of the choroid is plainly seen. Its general color is a brownish-gray, but the outer border is often of a darker hue, owing to a crescentic-shaped deposit of pigment in this situation.

The central surface of the disc is depressed below the general level, and of a whitish appearance. It frequently has a stippled look, caused by the holes through which the bundles of nerve fibers pass. It is at this point that the central artery of the retina and the accompanying vein pierce the optic nerve. The white appearance of this depression is due to the connective tissue enclosing the vessels.

Although the **central artery of the retina** usually pierces the disc at its center and bifurcates as soon as it emerges, one branch passing upward and the other downward, such is not always the case. The artery may appear at other points of the disc, and has been observed to emerge as several branches. After bifurcating, the branches continue to divide dichotomously, continuing in all directions toward the periphery of the retina. The veins enter the disc at a little distance apart, and correspond to the arterial branches, though the former are sometimes double. The veins are tortuous in their course and larger than the arteries. Sometimes a spontaneous pulsation may be noticed in the central veins, and this may be augmented by gentle pressure upon the eyeball. The veins are of a darker and of a more uniform color than the arteries, and they usually pass under the latter. The apparent caliber of the vessels will be found to differ with the magnifying power used. The arteries, in contrast with the veins, are straighter, of a brighter red, smaller, and the pulsation can not be seen. They usually cross over the veins, and along the center of each may be noticed a bright whitish line. This whitish line is scarcely observable on the veins.

The color of the disc is not uniform, the inner half being of a pinkish tint, and the outer half presenting more of a gray or mottled

appearance. The inner portion is more of a pink than the outer, owing to its being more thickly covered with nerve fibers and vessels. The central depression, its whitish appearance, the outer grayish mottled hue, and the more decided pink of the inner half, are all subject to considerable variation, but are characteristic marks in most healthy eyes.

The retina is so nearly a transparent structure that it reflects very little light, and is therefore generally invisible. In very dark persons it may sometimes be seen lying over the choroid as a grayish layer. Its appearance may well be likened to the bloom on a peach.

The **yellow spot (macula lutea)** is not easily recognized, but it is situated on the axis of vision about one or two lines outward from the disc. No retinal vessels cross the spot; they pass either above or below. This fact helps to determine its position more readily. The color generally seems to be a bright red, and in the center is a bright spot known as the central pit (**fovea centralis.**)

The anatomy of the **choroid** shows it to be a vascular and pigmentary structure. An elastic lamina lies innermost, and close behind this, separated from it only by the hexagonal cells, lies a dense capillary network. The larger choroidal vessels lie next to the sclerotic, and among them are distributed the most of the pigment cells. In persons of dark complexion, the hexagonal cells conceal the choroid from view; but in persons of a lighter hue, these cells contain no pigment and allow light to pass to the vascular structures. This explains the scarlet appearance of the fundus in the latter, and the brownish-gray appearance in the former.

Opacities occurring in the cornea, lens and vitreous are readily detected by the ophthalmoscope. As far back as the posterior lens capsule, as has already been noted, opacities may be seen in their true colors by lateral illumination, and even very minute ones may be detected; but with the mirror alone it should first be ascertained whether the media are clear. Once assured that an opacity exists, its depth should be determined, and then, if it is within range, the lateral illumination may be used. With the ophthalmoscope, opacities appear as dark spots of irregular size and shape on a red background. With the lateral illumination, they generally appear as gray or light spots upon a dark back-ground. With a very brilliant illumination, very small opacities may be invisible; it is therefore best to employ a very weak light at first.

In examining for opacities with the mirror, in order to prevent the image of the fundus from obscuring or confusing them, the mirror

should be held at such a distance as will prevent the observer from getting any image of the fundus. In order to do this, a lens of about eight inches focal length may be used behind the mirror and the latter be held at a distance of seven or eight inches from the eye under observation.

To determine the depth of an opacity, it may be remembered that all opacities in front of the posterior lens capsule are readily located by means of the oblique illumination. The turning point of the eye, or the point which remains stationary while the eye is in motion, is situated either at or a little behind, the posterior pole of the lens. Now if the eye is moved in various directions, opacities in front of this turning point, or pivot, will move in the same direction as the cornea; and it is likewise obvious that opacities behind this point will move in the opposite direction. An opacity situated at the turning point would scarcely move at all. The reflection of the mirror upon the cornea does not move with the movements of the eye. This corneal reflection should therefore be taken as the fixed point by which to measure the extent of movement of an opacity; and the extent and relative direction will show the approximate depth. Opacities of the cornea are best seen by the oblique method. The unaided eye will detect those of appreciable size, and the location, size and color can be easily determined. In opacities of the lens, spots are sometimes seen upon the anterior capsule, the posterior capsule and the lens being unaffected. Usually these are deposits of lymph or pigment resulting from iritic or corneal inflammation.

There are several **ways of determining the refraction of an eye.** The ways most used, however, are those of skiascopy, or oftener, that of finding the lens required by the observer (any ametropia of the observer being first corrected, and the accommodation of both the observer and the observed being fully relaxed) to clearly and distinctly see the fundus of the eye under examination.

In myopia the rays converge to a focus before reaching the retina. In other words, the principal focus of the dioptric media lies in front of the retina. Hence rays issuing from the retina of a myopic eye do not emerge from the cornea parallel, as is the case in emmetropia; but coming from a point beyond the principal focus, they emerge as convergent rays. They can not as convergent rays be brought to a focus upon the observer's retina, but after they cross each other and become divergent, the observer can obtain a distinct image. The image is an inverted one, as is proven by the fact that it moves in the opposite direction from the observer's head. The head of the ob-

server must be from twelve to sixteen inches from the eye under examination.

An erect image may be seen at a short distance by interposing a concave lens behind the mirror; but the lens should be of sufficient power to render the convergent rays parallel. The focal length of this lens will approximately represent the degree of the myopia existing in the eye under observation, and therefore the number of the lens necessary to correct it.

Parallel or divergent rays of light entering the hypermetropic eye converge to a focus situated behind the retina. The principal focus of the dioptric media is therefore behind the retina. Rays from the retina are therefore from points within the principal focus, and in consequence emerge divergent. At a distance of sixteen to twenty inches, these rays can be brought to a focus upon the observer's retina, and form a distinct erect image. That the image is erect is proven by its moving in the same direction as the observer's head.

Rays issuing from a hypermetropic eye may be rendered parallel by a suitable convex lens. The focal length of the lens which will render the divergent rays parallel, enabling the observer to see a clear, erect image of the eye at a distance of two or three inches, will give approximately the degree of existing hypermetropia.

The size of the inverted image is directly proportionate to the focal distance of the convex lens used; and other things being equal, that of the myopic eye is smaller, and that of the hypermetropic eye larger, than that of the emmetropic eye. But in estimating the degree of either hypermetropia or myopia by these methods, one source of error must be carefully guarded. It arises from the fact that comparatively few observers can, in looking at near objects, prevent the involuntary action of the ciliary muscle. To make the results of value, the accommodation of both must be relaxed during the examination. Repeated practice must be had until the observer can accomplish this relaxation, or an allowance must be made for that which can not be overcome.

To practice for this relaxation of the accommodation, emmetropes and hypermetropes may look through a convex lens at objects situated at the focus of the lens; and practice bringing their eyes to a parallel condition by placing before one eye a prism with its base inward. It may also be found advantageous to examine the inverted image through a moderately strong convex lens, as a plus 3D.

In most cases of astigmatism the refraction varies slightly in the different meridians of the cornea. Usually, rays entering the eye in

the vertical meridian are focused somewhat nearer the cornea than the rays in the horizontal meridian. The variation is usually so slight as to be unnoticed, but where the want of symmetry in the corneal curvature is great, confused and indistinct images are formed upon the retina and the condition is called astigmatism. Sometimes the crystalline lens presents irregular curvature also. By the direct method, in regular astigmatism, the optic disc appears oval, and the elongation is in the direction of greatest curvature. By the indirect method the reverse is true. Sometimes in normal eyes the disc is oval; hence if the disc appears oval in one direction while viewing the upright image, and astigmatism is present, it should appear oval in a direction at right angles to the first when viewing the inverted image.

The presence of astigmatism may also be determined by observing the relative distinctness with which vessels running in different directions are seen. For example, vessels running vertically may appear clearly focused, while those running horizontally are indistinct and confused.

Suppose the observer's eye is at a minimum distance and adjusted for parallel rays, but upon exerting the accommodation the first set of vessels becomes dim and the second set clear; manifestly it is a case of simple hypermetropic astigmatism. But if under the same conditions there can not be obtained by any accommodative effort a distinct image of the second set of vessels, the case is one of simple myopic astigmatism. In a case of compound hypermetropic astigmatism, if the observer's eye is at a minimum distance and adjusted for parallel rays, the vessels or other details can only be seen by exerting the accommodative power; and different degrees of accommodation will be required for successively focusing vessels running in the direction of different meridians.

Astigmatism may also be detected by the indirect method, for if the lens is held at its principal length from the eye and then gradually moved nearer, the disc appears more and more elongated in one diameter; but if, instead, the lens is gradually withdrawn, the disc appears elongated in the diameter at right angles to the first.

Skiascopy, or the shadow-test (also called retinoscopy) has two ways of use: the first, where the distance between the operator and patient is fixed, and the measurement determined by changing the trial lenses; and the second, where this distance is varying. The first way may be practiced with the ordinary concave ophthalmoscopic mirror (or with a plane mirror), and will be approximatively explained; the second way always requires a plane mirror, and will not be de-

scribed. To make use of the first way, place the patient with the back to the light, which should be about two inches higher than the head, and take a station four feet in front; have the patient look slightly to the left as you examine the right eye, and vice versa. Looking through the hole in the ophthalmoscope, as the light is reflected into the eye, the red fundus reflex will be perceived. As the instrument is now rotated very slightly, a shadow will come out from behind the iris and partly cross the pupillary space. If this shadow moves with the mirror, or in the same direction that the reflected light on the face moves, the case is one of myopia. If the shadow is well defined, and moves slowly against the mirror, hypermetropia is indicated. If the shadow moves obliquely, or if, instead of a solid shadow, dark and light lines cross the pupillary space, astigmatism exists. The degree of the ametropia is measured by the strength of the lens required to neutralize the ametropia disclosed.

Owing to the intimate relations of the structures at the fundus of the eye, it must not be expected to often find marked alterations in one part without more or less important changes in parts adjacent. In most cases were symptoms of disease exist which, directly or indirectly, may be referred to the fundus, it is well to explore this portion of the eye in all directions, taking the optic disc as the starting point. Very serious disorders may have their origin in the periphery as well as in the center or in other portions of the fundus, and the situation of any abnormal appearance should be carefully determined which may be done by noting its distance from the optic disc, and at the same time considering the direction from which the patient's eye is looked into.

Thinning and increased curvature of the cornea sometimes occurs while its substance remains transparent. This condition is known as **conical cornea.** A cone-shaped prominence involves a part or the whole of the cornea. Its summit is always blunt and its sides vary much in height and abruptness. This can usually be seen with the unaided eye. When simple inspection or the oblique illumination fails to detect an elevation of this kind, the ophthalmoscope may be employed. Using only the mirror and reflecting the light upon the eye from different angles, the side of the cone opposite the light will appear shaded or darkened. But such a test will not be needed, except in slight degrees of the affection.

Elevations and **depressions** of the surface at any point must not only be recognized, but must be distinguished from each other. With the binocular ophthalmoscope alterations in surface level

appear in their true characters, but the case is different with the monocular instrument. With the latter, attention must be directed to the course and appearance of the vessels, for as these ascend or descend from one level to another, they describe a more or less acute curve. A slight alteration in surface level will cause a very slightly perceptible curve; but on the other hand, the curve may be so abrupt and extensive as to hide portions of the vessels from view.

If the details of a portion of the fundus are clearly focused while those of closely adjacent portions are indistinct, we may suspect a relative difference in surface level unless the appearance can be accounted for by slight opacities. astigmatism or otherwise.

To ascertain whether a part is elevated or depressed, the tests for hypermetropia and myopia respectively should be applied. An elevated portion of the fundus will lie within the principal focus of the dioptric media and therefore be hypermetropic. The floor of a depression lies beyond the principal focus of the dioptric media and is myopic. By the direct method an image of each condition can be seen at a distance, the first erect and the second inverted. An elevation or depression in the base of the eye can be measured by mathematical calculations founded upon accurate estimates of the states of refraction of the summit and base of an elevation, and the margin and bottom of a depression.

SECTION THREE.

The lids are subject to the same diseases as other parts of the general integument, and require the same treatment.

The edges of the lids are especially liable to inflammation (**blepharitis**), and the glands may also become involved (**blepharadenitis**). The edges of the lids are first hyperæmic, then swell and become smooth and glossy. The altered secretion and discharges form small yellowish scabs, which adhere to the lashes. The latter fall out, and if replaced are apt to be stunted and ill-formed. When the edges become hardened, the condition is called **tylosis**; when the lashes are shed, **madarosis**.

When blepharitis is due to ametropia the refraction should first be corrected. When due to disease cleanliness is an excellent remedy, and to that end the matted lashes should be separated, and the

scabs carefully soaked and sopped away with a solution of soda (five grains to the ounce of distilled water), and cold cream or simple cerate applied. Should the disease be persistent, graphites ointment (three or four grains to the ounce of vaseline) may be used. The other troubles yield to the cure of this disease. Belladonna, silica, calcarea carbonica and graphites are among the best internal remedies.

Styes, or boils in the connective tissue, often appear singly or in groups. They are generally due to some derangement of health, which requires attention. If this is not the case pulsatilla or staphysagria will remove them.

A **chalazion,** or tarsal cyst, is caused by the obstruction of the orifice of a sebaceous gland and sequent retention of the secretion, forming a small tumor in the cartilage about the size of a pea. If not removed, inflammation causes them to become filled with pus. They may be removed by gentle evacuation or, becoming firmly seated, by the knife.

Ptosis is a drooping of the upper lid; **trichiasis**, an inversion of the lashes, whence they rub against the ball. Both affections may be cured by removing the disease causing them, or becoming severe, require the hand of the surgeon.

SECTION FOUR.

Diseases of the **lachrymal apparatus,** unless quickly subdued, are likely to prove very obstinate and trying to the practitioner.

Acute inflammation of the sac (**dacryo-cystitis**), or an abscess in the tear sac, is often associated with imperforate or misplaced puncta, nasal catarrh, and a chronic altered condition of the secretions of the mucous membrane of the eye. Exposure to rough winds, or a severe conjunctivitis may bring it about, or it may result from a chronic inflammation of the tear passages. Its earliest symptoms are tenderness, redness and a swelling over the region of the sac and lids, with excruciating pain. If allowed to progress the abscess bursts through the skin and intervening tissue, forming a **lachrymal fistula,** which usually remains unless surgically closed.

Hot lotions should be applied locally if the case is well advanced before seen; if not, iced compresses should be used and a thorough endeavor made to abort the attack. Failing in the latter, if unable to

slit the canaliculi, it is better to open the abscess with a knife than to allow it to burst. Suppuration should then be encouraged with internal remedies (hepar sulphur or silica) as well as local.

A chronic form of this inflammation (**mucocele**) is brought about by the same causes, but is much more difficult to cure. There is a constant irritability of the eye, and a watery condition. This latter condition (**stillicidium lachrymarum**) is, however, an accompaniment of lachrymal troubles, and proves very annoying. Strictures form in the duct, the sac varies in size according to the accumulation, and on pressure, a sticky, viscid fluid exudes. Owing to the unpleasant sensations, the patient usually presses out this exudation several times a day, obscuring the vision. After a time the caruncle sympathizes, and a very troublesome complaint is the result.

The treatment consists in allaying the irritation, opening up the canaliculi and probing the duct to remove the strictures. Seemingly not difficult, success is not attained easily in old cases. The channel once opened, astringent and antiseptic solutions should be syringed into the sac, and the membrane restored to a normal condition. Mercuric bichloride, one part to five thousand of distilled water, thus injected, is a valuable remedy. Persistence and thoughtful care oftener succeed than routine treatment. Silver probes are the best to use: of varying forms and sizes, they should be gently insinuated through the canals; when the strictures are obstinate and unyielding, they may be forcibly dilated or cut. The bone sometimes becomes affected, complicating the case. Inasmuch as syphilis plays an important part in lachrymal troubles, the probability of its presence should be considered. Calcarea carbonica, hepar sulphur and silica are among the best internal remedies in these affections.

SECTION FIVE.

Conjunctivitis, as its name implies, is an inflammation of the conjunctiva, a mucous membrane beginning at the continuation of the integument on the edges of the lids and extending over the lids, and by reflection on to the eyeball to the junction with the cornea. It consists of reticulated connective tissue, mainly composed of connective tissue corpuscles with a fibrous intercellular substance. It is richly

supplied with nerves, mainly from the fifth pair, and with blood-vessels.

These vessels are divided into the anterior and posterior, the former supplying the zone near the ocular conjunctiva, and the latter the posterior zone of that tissue. The anterior zone is connected with the episcleral vessels.

The arterial vessels are branches of those from the lids and lachrymal glands, and are reinforced by twigs from the angular, temporal and infra-orbital arteries. The veins anastomose with the orbital veins, and terminate in the vena angularis and temporal veins. The posterior are connected with the anterior, and the anterior with the ciliary system, thus explaning the rosy zone of vessels, with suffusion of the conjunctiva, so strongly marked in iritic and ciliary inflammations.

The classification of conjunctivitis is arbitrary, one form may run into another; but for convenience it may be divided into catarrhal, purulent, granular, diphtheritic and phlyctenular. In general it may be said that hyperæmia precedes the catarrhal form, and the catarrhal form precedes the purulent. All may be infectious and contagious, endemic or epidemic; the discharge from one form producing its own kind or that of another.

Catarrhal Conjunctivitis is caused by contagion, exposure, the exanthematous diseases, foreign bodies and injuries of all kinds, and less often by ametropia, bad hygiene and over use of the eyes.

It is not difficult to recognize. The subjective symptoms are a sensation of sand in the eye, more or less pronounced, with smarting and itching, while objectively the increased vascularity and lachrymation, with sticking together of the lids, especially after sleeping, render the trouble apparent. To these, when the disease has progressed a step farther, are added a mucous or muco-purulent discharge, containing whitish flakes of albumen and epithelial and mucous cells, chemosis more or less pronounced, and red, swollen and stiffened lids. Not infrequently numerous small infra-conjunctival hemorrhages are seen.

Under proper care it is seldom that the cornea becomes involved in this variety, but in the exanthematous diseases care should be taken that the conjunctiva does not become seriously implicated. Sometimes it does unless watched, and hurrying into the purulent form, involves the cornea, and damages or ruins the sight. This result is not infrequent in variola.

Extreme care as to cleanliness, isolation and disinfection of all towels, basins, etc., should be observed, as many cases are violently contagious.

If the inflammation is due to ametropia the refraction should be corrected by suitable glasses. If no cause is apparent, examine carefully for any local irritation, as from a foreign body, any inturning lashes, etc.

When the disease is fully established, insist on extreme cleanliness always. Cold applications may be used in the primary stages, with protection to the eyes. Mild, astringent lotions should be employed when necessary, such as two grains of zinc sulphate to the ounce of distilled water, or a similar solution of alum sulphate or argentum nitrate. Corneal and iritic complications may require atropine.

Tonic treatment must not be neglected if the patient is at all run down in general health. The disease is usually local, however, rendering such treatment unnecessary.

Purulent Conjunctivitis. The chief causes of the purulent form of inflammation of the conjunctiva are the same as in the catarrhal form, but greatly intensified. The discharge is purulent, thick and highly contagious, the conjunctiva highly swollen, and often great chemosis supervenes.

There is great danger of the cornea becoming involved, causing ulceration, sloughing, and not infrequently the loss of the eye. The corneal dangers and their treatment should be carefully considered; they are fully explained in Section Six. The gonorrhœal variety of conjunctivitis is usually very severe, and shows a great tendency to constitutional symptoms, which often are extremely severe, on its inception. Ophthalmia neonatorum may be very mild or very severe, and should be at once checked.

No eye disease requires greater judgment or a more careful course of treatment than purulent conjunctivitis. Extreme cleanliness is always necessary, and thorough disinfection must be accomplished and maintained. Cleanliness is best accomplished by removing the discharge with small pledgets of folded cotton cloth. It is not best to allow the palpebral syringe to be used, as it is difficult to control the danger of infection.

When the discharge has not set in, the conjunctiva being tense, hot and dry, soothing applications should be employed, such as atropine, and the way carefully felt. When the discharge is fully established, an astringent lotion every few hours may be used, or it may be necessary to paint the inner surface of the lids once or twice daily with a strong astringent. A solution of ten grains of silver nitrate to the ounce of distilled water is an excellent one. This should be applied with a camel's hair pencil to the everted upper lid, and neutralized,

when demanded, by a strong solution of common table-salt and water. Its repetition should be gauged by the severity of the case, but it should not be repeated usually until the discharge reappears. If the cornea becomes cloudy, atropine must be used every three or four hours. Canthoplasty may be performed if the lids press too closely on the globe.

The non-affected eye should be carefully sealed up, if necessary; in any event the greatest caution should be used that the disease is not communicated to it. Cool or iced applications may be demanded in severe cases.

In ophthalmia neonatorum, in addition to extreme cleanliness, one drop of a one-grain solution of silver nitrate should be dropped between the lids, night and morning, and a powder of argentum nitricum given every three hours internally. A weak solution of atropia sulphate may be used if the cornea becomes cloudy.

As this disease often greatly drains the system, and the gonorrhœal variety particularly so, the strength should be kept up. The room should be disinfected, and everything in use subjected to a similar treatment.

Granular Conjunctivitis.—The granular form of inflammation of the conjunctiva has been known under many names, and been a great bane to the world. The chief causes are catarrhal and purulent conjunctivitis, filth, impure air, and defective hygiene generally. Contagion, perhaps, is the greatest cause of the disease as ordinarily seen.

Locally this trouble is characterized by hyperæmia, swelling, and a peculiar roughness of the palpebral conjunctiva. These changes may be noticed as diffuse, vascular excrescences in the conjunctival tissue, resembling roundish granules; or as hypertrophied papillæ. The former is called granular trachoma, the latter, papillary trachoma; occurring together, as they most often do, mixed trachoma. There may be a discharge, at first thin and watery, gradually becoming thicker and of a muco-purulent character; or the disease may steal on so insidiously as to be established before really suspected. In the latter case the patient generally previously complains of the lids sticking together in the morning, with some roughness. When either acute, or established, the eyes are very irritable, accompanied by a sensation of sand, especially under the upper lid, and they become red and watery on attempting to use them. After a short time the lids become puffy, more or less flabby, and limp. All symptoms vary greatly in severity according to the nature of the attack. It is conta-

gious, often highly so, and all towels, utensils, etc., should be carefully isolated to prevent the danger of contagion.

The disease shows great tendency to relapses, acute exacerbations being common. It is often complicated with other diseases. The greatest danger lies in the injury to the cornea. The rough, sand-paper-like lids irritate the cornea, promoting vascularity and pannus, or the cornea may ulcerate. The conjunctiva may also become chronically dry (**xerophthalmia**), the lids be drawn inward at the margin (**entropion**), or outward (**ectropion**), the lashes turn in (**trichiasis**), or the lid or lids become firmly adherent to the globe (**symblepharon**).

Nearly always, general complaints accompany or have originated this trouble. It is particularly associated with the badly nourished; with high, free livers, who crowd their stomachs, drink hot stimulating drinks, remain in smoky rooms, or heated, close atmosphere, and take insufficient exercise. The mind is apt to partake of the bodily weakness in old, advanced cases, and the patient becomes addicted to lazy, indolent habits.

The local treatment consists of the protection of the eye from injurious influences and the use of a suitable irritant and stimulants. If there are present large, warty granulations, they may be snipped off. It should always be borne in mind that the object of the treatment is not to burn off the hypertrophied papillæ, but to cause their retraction and to absorb the granulations. To accomplish this they may be gently touched on the exact spot with a finely pointed pencil of cuprum sulphate, or a solution of silver nitrate or other suitable irritant, which must be changed from time to time. After application the irritant should be washed off or neutralized at once, or after a few seconds interval, as the effect desired is produced, and repeated daily or less often according to the success attained. Jequirity, alum, tannin and other stimulants may be useful. The application of cold water is often necessary after irritants have been used. Acute cases, or acute exacerbations of old cases may demand ice-bags.

It is difficult to convey by words the methods of successful local treatment, but unless it is painstakingly and carefully done, it is more than likely that harm will result instead of benefit. Each case must be studied separately, and a consistent course carried out.

All exciting causes should be removed, general bathing with friction employed, and good food, air and exercise, with healthy, useful employment, insisted on.

Diphtheritic Conjunctivitis is extremely rare in this country, and only appears in a comparatively mild form. A yellow, tough and firm product of inflammation collects in the tissue of the conjunctiva, and on its surface, from which it may often be torn off, like a thick lining of the lids. There are usually the symptoms of intense inflammation in the first stages, with great tenderness to the touch, the lids being hardened by a fibrinous infiltration. The symptoms vary much according to the case, but generally are severe at first. The lids grow soft as the disease advances, and pus supervenes. The greatest danger is to the cornea, which is apt to suffer severely, and the lids to become cicatrized. The constitutional symptoms are usually marked, and easily diagnosticated.

The treatment is not very satisfactory. Locally, iced compresses may be used in the first stages, and the treatment of purulent conjunctivitis employed when pus sets in. The strength should be supported and the case treated much as a case of diphtheria of the general system, with which trouble this is usually associated.

Phlyctenular Conjunctivitis is characterized by small, yellowish-red nodules on the conjunctiva, and is often associated with, and in many respects similar to pustular keratitis. It requires similar treatment.

Pterygium, or bat's wing, is usually caused by exposure to hot winds, such as the winds of the sea, of the prairies, etc. It is often sequent to chronic inflammations of the conjunctiva. It consists of a triangular, vascular ridge of hypertrophied conjunctival and sub-conjunctival tissue, usually on the nasal side of the eye, with the base toward the canthus, and the apex adjacent to, or more or less on, the cornea. It is often confounded with **pinguecula,** which may be due to micro-organism parasites, or a deposit of fat, and requires no treatment.

If remedies are unavailing, and the pterygium persistently encroaches on the cornea, excision, ligation or transplantation must be employed to remove it.

Among the internal remedies, aconitum napellus will be found valuable in all the forms of conjunctivitis in the early stages. It is particularly valuable in those cases which begin with much local fever and heat, where it is necessary to quickly break up this condition. In the first stage of catarrhal inflammation, when severe, or when there is a sensation of local heat, it is always indicated. In acute exacerbation of chronic granulated lids it is also indicated. It is of little value, however, when once the second stages have set in, or when the boundary is

passed in the catarrhal form, and the purulent form has set in. To subdue local inflammation after a hot cinder, or other foreign body, has been removed, it will be of value in conjunction with local remedies. The latter, however, will generally render it unnecessary.

Apis mellifica is a valuable remedy when the lids are swollen and stinging, with a general œdematous condition. The parts have that peculiar appearance as if a bee had stung them.

Argentum nitricum has long enjoyed the reputation of locally curing the purulent forms. It is also an excellent internal remedy in these forms, but is useful in the first stages only of the granular form.

Arsenicum is useful in the first stages of the catarrhal and granular forms, and the various stages of the pustular form, when there are burning pains especially at night. Periodicity of attack, and alternate shifting from one eye to the other also indicate its use.

Belladonna is useful in the first stages of conjunctivitis, that is in the precedent hyperæmia and catarrhal forms, but is of no use when the purulent form has set in. In the early stages it will meet such symptoms as smarting and burning pains, with dryness and heat, and marked photophobia. Often the face is red and swollen, with headache. Acute attacks in chronic cases may demand this remedy.

Euphrasia finds in the conjunctival troubles an appropriate sphere of action. When called for, there are profuse, acrid burning lachrymation, and a thick, profuse yellow discharge, which run down on and excoriate the cheek. Owing to the presence of this discharge on the cornea, vision is more or less impeded, but relieved by the act of winking, which washes down the obstructing secretion. It must not be depended on in the purulent form, however, as it will seldom be of sufficient power to bring about a healthy resolution. More especially is this the case if the cornea is threatening suppuration.

Graphites is not a very useful remedy in any of the conjunctival forms but the pustular. When the external canthi crack and bleed easily, and eczematous eruptions appear behind the ears, the discharges being thin and excoriating, the nose participating, with a general scabby condition, and dry scurfs, with a decided tendency to recur, its use will be strongly demanded.

Hepar sulphuris must always be thought of when, in the purulent form, the cornea has become implicated, and there is a strong suppurative tendency or suppuration has actually set in. It may be useful where there is a muco-purulent discharge.

Ipecacuanha is an admirable remedy for subduing the pustular form.

Mercurius is a valuable remedy. Special indications are found in the profuse, burning, muco-purulent discharges. They are thin, acrid and excoriating. Syphilitic subjects particularly require its use, and the well-known train of symptoms classed under this name will guide in its selection.

Nitric acid may be used in gonorrhœal ophthalmia, in conjunction with local treatment.

Pulsatilla nigricans is a valuable remedy in almost all forms of conjunctivitis. In the catarrhal form when occurring in the characteristic subject, with a bland, thick discharge, it is indicated, and especially in this form resulting from an attack of the measles, or from taking cold.

Rhus toxicodendron is valuable when the inflammation is caused by exposure to the wet, with an œdematous swelling of the lids.

Sulphur is the remedy for certain forms of, and conditions associated with, phlyctenular conjunctivitis. Agglutination in the morning, marked photophobia and profuse lachrymation, burning and biting in the eye, with sharp lancinating pains, are indications for its use. Chronic, scabby cases, occurring in scrofulous children, will be benefited by its administration intercurrently with other remedies.

SECTION SIX.

The **cornea** is a horn-like substance, and supplies the anterior one-sixth of the external tunic of the eyeball. It is a transparent, firm, elastic, fibro-cellular membrane, and is to some extent a direct continuation of the sclerotic, with which it forms the outer covering of the globe, and into which it fits as a watch-glass fits into its frame. Its average thickness is one millimeter, or $\frac{1}{25}$ of an inch, growing thinner from the center toward the margin.

The cornea is also a laminated membrane, consisting of five distinct layers. The first, or outer layer, is composed of epithelium—the continuation of the epithelium of the conjunctiva, and is about $\frac{3}{2500}$ of an inch thick. The second layer (Bowman's membrane) is a firm, elastic, homogeneous membrane, $\frac{1}{2500}$ to $\frac{1}{5000}$ of an inch thick. The third layer (the true cornea) consists of fibrous and connective tissue in the form of lamellæ, and constitutes the chief bulk and strength of the cornea. Its thickness is nearly $\frac{1}{25}$ of an inch, and it is a modification of the sclerotic, with which it is continuous. Between the lamellæ

and the fibrils, of which they are composed, are spaces filled with serum and lymph, with corneal corpuscles and wandering cells. The spaces anastomose, and form a system of canals, through which the cornea receives its nutriment, for the cornea in health has no blood-vessels (except at the extreme periphery), but derives its nourishment from the numerous vessels surrounding its margin. These vessels are derived from the episcleral branches of the anterior ciliary arteries. It is exceedingly well supplied with nerves, having from thirty to forty twigs entering its substance, and forming complicated plexuses beneath Bowman's layer and behind the true cornea. From these networks of nerves, numberless little fibers proceed outward to terminate among the epithelial cells of the external layer.

The fourth layer (Descemet's membrane) is from $\frac{1}{2500}$ to $\frac{1}{3500}$ of an inch in thickness—an elastic, structureless membrane. The posterior layer of the cornea—the fifth—is a very thin layer of epithelium covering Descemet's membrane.

Keratitis. In general terms, it may be said that inflammation of the cornea is caused by inflammation of the adjacent parts, by constitutional disease, by bad nutrition, by injuries and by exposure.

The most common adjacent inflammation which is liable to affect the cornea, is conjunctivitis. Purulent conjunctivitis cuts off the nutrient supply which the cornea needs, and not unfrequently brings on destructive ulceration, and sloughing. Neglected granulations on the lids, by constantly rubbing over the surface of the cornea, excite roughening, cloudiness and vascularity of its surface, which, if unchecked, end in ulceration.

It is owing to the great importance of the cornea as a part of the organ of vision that the results of inflammation are so much to be dreaded, for not only are destructive changes apt to be rapid, but the changes incident to repair are necessarily slow.

Of all constitutional diseases which bring about inflammation of the cornea, the most strikingly characteristic is hereditary syphilis. Strumous subjects are especially liable to its ravages, and syphilitic and scrofulous keratitis were formerly confounded. Poorly fed and scantily clothed children, who are subject to the vicissitudes of poverty, fall an easy prey to corneal affections, and the same is true of persons suffering from great debility of any kind. Corneal incisions in cataract operations; blows and wounds of all kinds upon its surface have a marked tendency to inflammation, and trivial causes should never be overlooked.

Inflammations of the cornea assume various forms. Independ-

ently of the peculiar characteristics of each form or variety, there are certain symptoms common to all varieties. These attendant symptoms are ciliary irritation, a rosy zone of vessels around the corneal margin with conjunctival congestion, contraction of the pupil, pain, photophobia and lachrymation, and impaired vision.

Perhaps the most characteristic of the attendant symptoms just given is the contraction of the pupil. This and the pain are due to ciliary irritation. The ciliary irritation also produces others of the symptoms, including the zone of vessels mentioned. In many cases, photophobia, with sequent lachrymation, is due to loss of the epithelium (the outer layer), thus exposing the terminal filaments of the ciliary nerves. The impaired vision may be due to corneal opacity in front of the pupil, to turbidity of the aqueous humor from exudation of lymph, or to the indirect influences upon the retina of the inflammatory process in the other parts.

Keratitis may involve the whole or a part of the cornea, and is named according to the predominant kind of inflammation present. For convenience it may be divided into vascular, pustular, suppurative and interstitial.

Suppurative Keratitis is the form which forebodes the greatest danger to the vision, and which unrestrained accomplishes almost certain destruction of the cornea. The infiltration changing into pus characterizes the form.

The chief cause of this formidable trouble is some form of purulent conjunctivitis. If this is not speedily brought under control, there results a destruction of corneal tissue. If this is controlled before perforation takes place, an **opacity** forms of size, density and shape proportionate to the slough, and affects vision by intercepting the rays of light, in a greater or lesser degree, according to its situation in or approximation to the visual axis. When such opacity forms in the epithelium, it is called **nebula;** when in Bowman's layer, **albugo.** But should perforation take place, a **prolapse of the iris** results (hernia iridis), and if allowed to remain, plugs up the hole and becomes attached from the lymph poured out. Nourished from the highly vascular supply of the iris, this prolapse may become firmly impacted with the corneal tissue (**leucoma adherens**).

If the tendency to necrosis is not rapid, the inflammatory infiltration changing into pus appears as a yellowish product in the cornea, forming an **abscess.** Should an abscess burst, it forms an **ulcer.** But ulcers also form without precedent abscess. If the pus lie simply between the plates, the peculiar shaped appearance, which it makes

from sinking in accordance with the laws of gravity, is called **onyx** or **lunella.** Perforating the plate backward, the pus escapes into the aqueous chamber and forms **hypopion** separately or in conjunction with lunella. When the inclination to **sloughing** is rapid, and the cornea becomes turbid, swollen and thinned, it may burst and its contents prolapse, forming **anterior staphyloma.** Should this dangerous accident happen, vision is almost sure to be damaged or destroyed. A combination of causes tends to bring about this dreaded result, but the most potent cause is an increase of intra-ocular tension through the hypersecretion of the aqueous humor, and the latter is more surely brought about if the iris becomes implicated in the disease.

When the cornea and iris have become staphylomatous, the irritation caused by such a condition jeopardizes the companion eye, while the unsound one is left in its place. The removal of such a damaged eye is often advisable to protect the other from sympathetic ophthalmia. Some prefer to excise the anterior portion only of the globe. The contents are then evacuated, and the remnants brought together form a good stump for an artificial eye, but the danger of sympathetic trouble still remains to a certain extent.

A pressure bandage may be applied to overcome the intra-ocular pressure and paracentesis (fully explained in Section Seven), or iridectomy performed. The former is a palliative measure, needing frequent repetition, but the latter once performed is usually sufficient.

For treatment one of the first indications is to support the general strength, and thus indirectly the corneal tissue. Even though this is successful only in part, a cornea tending to suppuration may be so strengthened that it will only bulge, and the main shape of the globe, though with dulled sight, on account of the changed curvature of the refracting surface of the cornea, be maintained. The supporting of the strength being attended to, attention may be given to the local treatment. This, in the beginning, should consist of atropine, rest and pressure. The two latter are attained by the use of the pressure bandage. Bandaging is one of the most important things in this connection, for by its use, cases which yield to no other remedy quickly succumb to it. Occasionally eserine does better than atropine, proving itself of value when atropine fails. It is also at times specially indicated for its myositic action, as when the perforation is near the periphery, it then drawing the iris away from the wound by stimulating its contractility. No irritant, such as silver nitrate, or any of the lead preparations, are permissible in acute keratitis. Old, chronic, indolent ulcers, showing little disposition to heal, may sometimes with

advantage, however, be touched with weak silver nitrate to stimulate them, but superficial opacities generally recover without remedial aid. All local irritants hasten tissue changes.

It is not wise to allow large abscesses to burst; paracentesis should be performed through their bases. Whenever the iris prolapses, it is best to snip it of with the scissors unless it will draw in under the action of a mydriatic or a myositic.

For the pain, which is sometimes very severe, hot water is usually sufficient. This not only allays the pain, but promotes the efficacy of the atropine and assists the process of healing.

A large opacity gives an unsightly appearance to the eye, and to cover this, and thus greatly improve the personal appearance, the operation of staining the cornea with India ink has been devised. Staining or tattooing the cornea is not without its dangers, owing to the inflammation it may set up. It is preformed by rapidly puncturing the superficial layers of the cornea with a number of fine needle points dipped in a solution of India ink, many sittings being required to perfect the operation. Other solutions of various tints are used, and skillful hands will often give a remarkably natural appearance to an eye whose unsightly appearance greatly annoys its possessor. An opacity situated so as to entirely obstruct vision, may be surmounted by making an artificial pupil in a remaining clear portion of the cornea.

Vascular Keratitis is characterized by gray opacity of, and development of vessels on, the roughened surface of the cornea. It is a tedious disease, but as time goes on the vessels grow smaller, gradually withdraw toward the palpebral margins, and slowly disappear, though often failing to leave the cornea clear. The differential diagnosis between it and pannus is explained farther on.

For local treatment, protection and rest of the eyes, with hot water and atropine have been found best. In cases of excessive inflammation, cold applications may be found useful.

The general system is always at fault, and must receive careful attention.

If a case of suspected vascular keratitis is examined carefully it may be found that instead of a precedent hyperæmia and sequent delicate vascular loops pressing into the cornea, which are characteristic of vascular keratitis, there is an hypertrophied epithelium with a superficial, coarse and abundant supply of vessels, which, though closely simulating the former at a hasty glance, are seen to be quite different in the respects pointed out. This is **pannus.** and the essential dif-

ference is this—that the epithelium is hypertrophied and firmly adherent, while in the vascular form of the keratitis the epithelium is loosely adherent, often shed, and when so, the cause of severe and protracted pain. On the contrary, there is never any pain from pannus, for it securely covers the terminal nerve filaments, rendering them inaccessible and free from exposure, the cause of pain.

Pannus is most frequently caused by neglected granular conjunctivitis, or other diseases of the lids, which, by constant rubbing over the surface of the cornea, promote irritation and vascularity. When fully developed vision is partially or totally obscured. Successful treatment of the granulated lids or inverted lashes which cause the pannus, will generally be followed by its disapearance, but it is not always so easily cured.

In cases of total pannus, after all the other remedies have failed, inocculation with jequirity may be tried.

Phlyctenular Keratitis is characterized by circumscribed inflammatory nodules, singly or in groups, in the superficial layers of the cornea, oftenest at the margin. Its causes are obscure, but it is particularly associated with the weak, nervous and badly nourished, and shows a strong tendency to become epidemic. Patients who suffer from some of the many forms of catarrh are quite likely to contract it. In connection with the eruptions of herpes, eczema, etc., it appears, or through any irritation of the ciliary nerves.

After these nodules have remained a short time, vesicles form on them, and bursting, make ulcers. By reason of a nerve filament becoming implicated, these **ulcers** are the cause of photophobia and pain seemingly wholly out of all proportion to the lesion. The lachrymation is hot and scalding, all the secretions from the eye become acrid, and flowing over the delicate skin adjacent, render the parts tender and excoriated. It is often combined with a similar form of conjunctivitis.

The protective bandage, atropine and internal remedies are usually sufficient to cure a mild case. Where the disease seems firmer seated, with much photophobia, pain and lachrymation, and the patient, especially if a child, is inclined to bury the head in the clothes, or force it down upon the chest, a compress bandage may be needed. Absolute cleanliness of the lids and eye is essential, and locally a weak solution of mercuric bichloride (one to five thousand), or a mild solution of boracic acid, will be found useful.

Interstitial Keratitis. It is a notable fact in relation to all syphilitic diseases, that it is difficult to draw from the patients, or

from the interested parties, a true history of the case. Sometimes a full and free confession will be made at once; but more often questions are evaded or all knowledge of the nature of the disease is denied. However, in any well-marked case of a hereditary nature, denials are of little avail. The symptoms are as full of meaning, and point as plainly to the nature of the affection as words of the most graphic kind.

Interstitial Keratitis usually occurs between the ages of five and eighteen years in children who have inherited syphilis. It is a disease of slow progress, usually attacking one eye first, and in the course of a few days or weeks extending to the other.

At the outset of an attack of this disease, the cornea, on close inspection, presents a faint, cloudy appearance in one or more spots, or numerous little dots of a hazy appearance are scattered through its structure. Before these have become clearly visible, the patient has usually been annoyed by some slight photophobia and lachrymation. As the disease advances, the whole cornea becomes more or less opaque, assuming somewhat the appearance of ground glass. The opacity of the cornea, from the beginning to its height, is due to the progressive infiltration of its structure with a grayish or yellowish-white product. This infiltration shows very little tendency to break down and usually remains collected more densely in some regions than in others. By the time the disease is well advanced in one eye the other generally begins to be affected. Six to eight weeks is usually sufficient to develop a well-marked case, though the disease may reach its height in much less time. Cases may be mild or severe; rarely the cornea becomes almost completely covered with vessels. Under proper treatment, most cases recover, but the disease may recur, and the vision remain much damaged.

The features to which attention is drawn, are peculiar accompaniments of the inherited syphilitic taint. These are the scarred and flabby skin usually present in these patients, with the flattened bridge of the nose, and the small, irregular teeth with the peculiar vertical notch of the upper central incisors.

If a case appears to be at all doubtful, or if while the cornea shows unmistakable evidence of changes similar to those described, the usual accompanying characteristics of the disease are absent or obscure, careful investigation may reveal other conditions equally conclusive.

The history of specific disease in the parents may be sought out. The forms of disease to which the patient has been subjected should be ascertained, and if these correspond to any of the many affections

due to hereditary syphilis, the evidence is more complete. Chronic enlargement of glands, ulcers in the throat, psoriasis, exostoses, etc., are all manifestations of the true nature of the difficulty; some of these are usually present, or have been. But the most constant, peculiar and reliable symptom is to be found in the malformation of the teeth. The permanant set, upper central incisors, are the ones which require particular notice, though the others often are small, dark-colored and misshapen. The various forms should be familiarized, and not all notched teeth declared due to syphilis, even though the upper central incisors are the ones affected.

After the malformations of the teeth, the next most reliable indications are in the condition of the patient's skin, and the shape and structure of the nose and forehead. The skin has a dull, heavy appearance, is usually thicker than ordinary, and covered with seams and scars, the result of previous eruptions. The mouth often shows at the corners seams extending out into the cheeks; these are not constant, however. The frontal eminences are large and prominent; the bridge of the nose is often broad and sunken. The state of the finger-nails is sometimes charasteristic, being broken and split, but not so constant as that of the hair, it being dry and scanty.

If the case is one which has passed through the eye troubles peculiar to the affection, a hazy state of the corneæ may be seen, and a lusterless condition of the irides behind them. But there is no deviation from the normal appearance in eyes which have not thus suffered, they retaining their natural brilliancy, sometimes seemingly brightened by the appearance of the surrounding skin.

Statistics show that a very large percentage of cases of interstitial keratitis occurs between the ages of eight and fifteen years. Enlargement of the glands, so common in strumous subjects, are nearly always absent. Numerous special affections are accompaniments of the disease. Among these are deafness, tinea tarsi, cicatrices in the soft palate and pharynx, enlarged joints, etc. Another marked point is that the patient is generally the eldest of the family. Failing in this, the next in numerical order is usually the one afflicted.

It is extremely seldom that one eye only is affected. Both participate in the process of the disease, but seldom is the attack simultaneous, but at the interval of a few days or a few weeks. Iritis is not a frequent accompaniment, and when present it is not of that violent type noticed when the syphilis is acquired, and it is rare to find the pupil occluded as the result.

The subjects of this disease are also usually members of a family

in which infantile mortality has been well marked. When such has not been the case, the subjects have presented the usual infantile accompaniment (rash, anal ulcers, prolonged snuffles or sore mouth), or been "exceedingly difficult to raise," being delicate and sickly in infancy, and often puny in childhood.

If seen early, and before the cornea has become involved to a great extent, a favorable prognosis may be given. In the severest cases, if the eyes are extremely intolerant of light, a much more guarded opinion must be expressed. Changes take place in the structure of the cornea, and often on recovery from the photophobia sufficient to permit, it will be discovered that the cornea is misshapen. Sometimes it breaks down completely, though more often it will rally from the severest form of apparent destruction. The co-existence of inflammation of the deeper structures, especially the choroid and retina, may be suspected, and the influence of their damaged condition taken into account in making an estimate of the probable condition of the sight.

But little can be expected in the way of prophylaxis. The remedies so powerful in acquired syphilis are impotent in the hereditary form. The patient should enjoy, when possible, the advantages of change of air and scene, a liberal diet, etc., for even though these do not really accomplish anything in a prophylactic way, they conduce to a healthy condition and tone of the general system.

The treatment should embrace a good supporting diet and a carefully selected internal remedy. Locally, many cases need nothing more than protection by blue glasses and rest; in severe cases, without atropine and a supporting bandage, blindness might result. The various mydriatics and myositics must be thoroughly studied, and used or changed as good judgment and experience shall dictate. Where there are severe photophobia, blepharospasm, lachrymation and intense pain, it may be necessary for an attendant to open the eyes occasionally and keep them open. When atropine affords no relief by reason of its not being absorbed even after the most careful attempts with hot water or steam, iced water dropped on the cornea for a few minutes, and repeated often during the twenty-four hours, will relieve. Such treatment should be used carefully, however, for fear of other troubles resulting.

Among internal remedies, aconite will be found useful in ulceration of the cornea, when the characteristic symptoms are present, and the patient is restless, thirsty and feverish. A dry condition of the conjunctiva is an indication for its employment. Ulcers due to injury also call for this remedy.

Apis is indicated when there are stinging pains, with a swollen, œdematous condition of the lids. A tendency to swelling of all the adjacent parts is well marked in the condition referred to, accompanied by the characteristic pains. Chemosis is often well met by this remedy.

Argentum nitricum is a standard remedy in the ulceration of the cornea, often attendant on the form of conjunctivitis known as ophthalmia neonatorum.

Arsenicum has been used to great advantage in those forms in which the ulceration is accompanied by profuse and burning lachrymation with intense photophobia. The pains are worse at night, and are burning and sticking. The lids are often spasmodically closed, excoriated by the acrid lachrymation, and swollen.

Calcarea carbonica has been found one of the most useful of remedies. It is especially adapted to the form of keratitis occurring in fat, unhealthy children, who are extremely liable to take cold. The scrofulous diathesis particularly calls for this remedy.

Cimicifuga has been found very useful in wandering, shooting, pains, in connection with deep ulceration.

Conium maculatum has the power of relieving the marked photophobia in superficial ulceration of the cornea, whereby the terminal filaments of the nerves in Bowman's layer become exposed. This trouble is one of the commonest and severest in apparently slight ulceration, for on casual inspection there seems to be but little cause for the intense pain, there being little or no redness of the conjunctiva. The lids are usually closed spasmodically, and on being opened the tears gush forth. The body is bent upon itself, and the head often held down firmly upon the body.

Graphites is an excellent remedy, and when prescribed according to its indications, gives good results. It is specially valuable in corneal ulcerations which occur in scrofulous children with eczematous eruptions, especially when these eruptions are found behind the ears. An acrid discharge from the nose, which is often covered with scabs, is frequently present. Bleeding and cracking of the external canthus usually accompany the other troubles when this remedy is indicated.

Hepar sulphuris is invaluable in the suppurative form. Evacuation of pus from the anterior chamber is rendered unnecessary by the use of this remedy. Abscesses of the cornea frequently require no other internal remedy.

In superficial ulceration, mercurius finds its sphere of action; in the deep, sloughing forms it is not so reliable. It is often called for in the vascular form, and not infrequently in the phlyctenular.

Superficial ulcers are benefited by the administration of nux vomica. It is also an excellent remedy in the neuro-paralytic forms. Its well-known power after drugging is not to be forgotten.

Pulsatilla is one of the mainstays in the pustular form, when occurring in the characteristic subject.

Rhus toxicodendron does good service in the superficial forms when produced by getting the feet wet, or as the result of wet clothing. Chemosis yields to its administration.

Spigelia is useful in the sharp, shooting pains which pierce in deep ulceration. The eyeballs hurt on moving them, and seem as if too large for the orbits.

Sulphur is said to have an immediate effect on the sharp, sticking pain—pains as if a needle were thrust into the eye.

SECTION SEVEN.

The **iris** is a circular curtain or diaphragm stretched across the anterior portion of the eyeball just behind the cornea, and perforated a little to the nasal side of its center by a circular opening called the pupil. It divides the anterior portion of the eyeball into two chambers, the anterior and posterior, which are occupied by the aqueous humor, in which fluid the iris is suspended. The pupillary margin rests upon the anterior capsule of the crystalline lens. Upon this surface it glides smoothly in the movements of contraction and dilatation.

Through the pupil the anterior and posterior chambers communicate, and through the same aperture all of the rays of light pass to the retina. Until the seventh month of fœtal life there is no pupil, its place being covered by the pupillary membrane.

The iris is to a great extent continuous with the ciliary muscle which lies at its circumference; it also is firmly attached to the posterior layer of the cornea by the suspensory ligament (ligamentum pectinatum). The continuation of these fibers into the iris gives the latter its fibrous element. The stroma is composed of connective tissue continuous with that of the ciliary body and choroid; and within its meshes lie numerous blood-vessels, nerves, lymphatics, and a great number of pigment cells, which make up the parenchyma.

The arteries are derived from the ciliary, and form the greater

arterial circle of the iris. This lies in the ciliary muscle, and from it numerous branches are given which run toward the pupil, near the margin of which the lesser arterial circle is formed. The veins pass backward and empty into those of the choroid.

The nerves are derived from three sources—the third, the fifth and the sympathetic. The muscular fibers, chiefly involuntary, consist of two sets, the circular and the radiating. The former surround the pupil, forming the sphincter of the pupil, the latter converge from the ciliary border toward the pupil, uniting with the sphincter. The action of the third nerve is manifested by contraction of the pupil through its influence on the sphincter muscle of the pupil; the action of the sympathetic is manifest by dilatation of the pupil through its influence upon the dilator muscle of the pupil.

The movements of the iris are reflex through the action of light upon the retina, and accommodative, depending upon the action of the ciliary muscle in accommodation.

The iris is a very highly organized structure, exceedingly delicate, and therefore nature has well provided for its protection. Behind the firm and protecting cornea, suspended in a fluid which affords equal pressure in all directions, it appears very unlike the frail membrane that it is. Removed from its aqueous chamber, it often has scarcely more consistence than a spider-web. Yet its nervous and vascular supplies are so abundant, its relations to adjacent organs so close, and the part it plays in the visual act so important, that not only is it peculiarly susceptible to take on inflammation from slight causes, but the changes wrought by inflammation, neglected or improperly treated, are especially to be dreaded.

The causes which produce **iritis** are numerous, but the chief ones are exposure, rheumatism, syphilis, injuries, and the extension of inflammation from adjacent parts. It also forms an important part of those serious diseases known as sympathetic ophthalmia and glaucoma.

Any classification of iritis is arbitrary; nevertheless it has distinctive characters, so for convenience it may be divided into three forms: The **plastic,** characterized by plastic exudation; the **serous,** characterized by hyper-secretion of the aqueous humor; the **parenchymatous** or suppurative, characterized by well-defined nodular masses, which are reddish-brown at first, then yellowish and tend to suppuration. Each form, however, may run into or be combined with another. It may also be either acute or chronic, and may present all degrees of severity. There are symptoms more or less attendant on all varieties. These are changes in color and texture of

the iris (a light iris becomes greenish, a dark iris brownish-red); alteration in form and mobility of the pupil (the iris being sluggish); suffusion of the conjunctiva, with a zone of vessels around the corneo-scleral junction, which zone may be red, blue or brown; pain, which is variable and may be absent; photophobia and lachrymation; and the vision always impaired.

The symptoms which mark a case of iritis are but the manifestation of other changes as well; for seldom, if ever, does the iris take on inflammation without the parts in close anatomical relations sharing in the disturbance. The iris is a continuation of the ciliary body and of the choroid, and these always suffer to a greater or less extent when the iris is diseased.

Pain is a symptom of iritis which is more or less constant. It may be slight, amounting to only to an uneasy feeling about the eye and corresponding side of the head, or it may be an intense, unbearable pain, shooting, throbbing, sticking in character. Its favorite seat is usually over the brow or along the side of the head or down the side of the nose. It intermits at times, and is usually much worse at night.

Until iritis is fully established many of the symptoms simulate those of keratitis and other diseases; so, as would naturally be expected, the most reliable diagnostic symptoms are the changes which may be seen to take place in the iris itself. The changes in the color and texture of the iris are always observable features of the disease, and need not be mistaken in any case where the patient has two eyes and only one is diseased. The iris loses its brilliant color; its texture and hue become coarse and confused and muddy. Often the aqueous humor is turbid, and this apparently adds to the abnormal appearances in the iris itself. The iris is also very sluggish, and reacts but slowly to the influence of light. The application of atropine to the affected eye may be followed by slow dilatation of the pupil, or the pupil may dilate irregularly, showing partial adhesions of the iris to the lens, or it may not dilate at all, owing to its whole circumference being adherent to the lens capsule. **Synechiæ** are adhesions of the iris to either the cornea or anterior lens capsule, and these conditions are called anterior and posterior, respectively. When the area of the pupil is encroached upon by exudation, the condition is called occlusion of the pupil; when the pupillary margin is entirely adherent to the anterior lens capsule, exclusion of the pupil.

The rosy zone of vessels around the corneal margin is always present in this disease; it is due to congestion of the sub-conjunctival vessels around the cornea, these vessels anastomosing with those of the

iris and choroid. The conjunctiva may be so reddened and swollen as to obscure this symptom altogether, and the amount of the sub-conjunctival congestion differs much with the severity of the disease.

Photophobia and lachrymation are very common symptoms of acute iritis, and give the patient much inconvenience and pain upon exposure of the eyes to light.

The impairment of vision in ordinary cases of iritis is due to the turbid condition of the aqueous humor. If the vision is much impaired it is often due to the ciliary body and vitreous humor being considerably involved. Tenderness on pressure over the ciliary body is a sufficient indication of its implication.

The essential point in the treatment of iritis is to attack it with remedies promptly. Inefficient dilatory treatment allows synechiæ to become firmly organized and set up much internal trouble.

Perfect rest for both eyes, the shutting out of bright light, and protection from injurious changes of temperature should be assured. These are best accomplished in all extreme cases by keeping the patient in bed in a darkened room until the active symptoms are over. Except in the very worst cases this is unnecessary though often desirable; but where this is impracticable and the patient must go about, or in milder cases, a pad and light bandage to the affected eye to prevent movements of the lids, as well as to shut out the light, and a shade, or a flat blue glass to the sound eye, will be the next best plan. The latter precaution may often be wisely omitted. As soon as expedient, however, if it has been found necessary to confine the patient in bed, or a darkened room, send him out of doors.

It is also essential to secure complete rest for the inflamed iris. For this purpose a solution of atropia sulphate is best, and full dilatation of the pupil is the guide, and in most cases is essential to success. Atropia should be continued some days after all inflammation has apparently subsided. In serous iritis, a paracentesis of the cornea is demanded, unless atropine and hot applications relieve early. **Paracentesis** is done by thrusting through the cornea at its periphery and parallel to the plane of the iris, a paracentesis needle, thus allowing the aqueous humor to escape. Great harm is often done to the delicate parts of the eye by dilatory treatment. **Hypopion** is well met by remedies, and seldom requires to be evacuated. In the parenchymatous form, anterior synechiæ may form and require to be broken up. Iridectomy is often required in serous iritis of a severe type, and may be required in severe parenchymatous iritis due to syphilis. When there is great intra-ocular pressure, atropine will not

always work until the pressure is relieved by paracentesis or otherwise.

In those cases only in which there are no synechiæ likely to form, can a mydriatic ever be dispensed with. It is better not to omit it, as even the experienced might err.

The reason is plain. If there is exudation from the iris, and it is not drawn away from its resting place, the anterior lens capsule, synechiæ must form, and more or less firmly tie down the iris. Neglect of the instillation of a mydriatic for this purpose alone (laying aside for the moment all the other advantages enumerated for it in Section One), in cases of exudative iritis, will bring about complications not only highly injurious to, but often destructive of, the integrity of the globe, entire loss of sight being a not infrequent result.

"It is much to be wished that all persons who may, by any possibility, be tempted to prescribe for eye disease without knowing anything about it, would at least lay to heart the cardinal truth that a solution of atropine, although it may fail to do good, will in many cases be very serviceable and can scarcely ever do any harm. Astringents, on the other hand, although highly conducive to the cure of conjunctival affections, may be productive of irreparable mischief when either the cornea or iris is inflamed. A commencing iritis treated by a nitrate of silver lotion is apt to be stimulated into a state of intensity which is hardly ever seen under other circumstances."

The use of cocaine to allay pain in iritis, though usually successful in this respect, is attended with danger. To be effective it must be used strong and often, and the effect on the cornea is often disastrous.

Pain is best subdued with water as hot as can be comfortably borne. Cloths folded to a size suitable to cover the eye and adjacent regions are to be wrung out dry enough to prevent running and then quickly placed upon the parts, and gently pressed down. They should be allowed to remain but a few seconds, when they should be replaced. Success is brought about by careful attention to the details of this simple affair. Bits of hot wool or similar contrivances may be used, but are not usually successful in severe cases.

Complications with the neighboring tissues should be kept down. Nothing is more beneficial to iritis than plenty of sleep. Owing to the pain and a general restlessness, this is sometimes difficult to obtain, and its accomplishment should receive careful attention.

The fundus of every eye is colored by the pigment of the **choroid** and the choroidal blood vessels. The amount, distribution

and color of the former, and the amount and quality of the blood in the latter, modify the color of the fundus in individual cases. The more pigment the fundus contains, the darker its hue. This is owing to the obscuration of its blood vessels, and the sclerotic. When any part of the fundus becomes destitute of pigment, the white sclerotic is seen shining through.

In an ophthalmoscopic examination the abnormal conditions of the choroid show these features of importance, viz., hyperæmia, inflammation, tumors, coloboma, tubercles, rupture, changes in, or causing myopia, hemorrhages and detachment.

Unless one eye only is involved **hyperæmia** is not easily determined. Even then, the varying conditions of pigmentation may mislead. However, increased caliber and redness of the choroidal vessels at any point should be regarded as partial evidence; and if, added to this, the optic disc is hyperæmic and its outline indistinct, the evidence is still more complete.

Inflammation of the choroid as in retinitis presents several distinct forms, but the exudative presents the most marked ophthalmoscopic appearances. In the other forms the appearances are less definite.

Exudative choroiditis, or choroiditis disseminata, is a form of choroidal inflammation in which plastic deposits take place. These deposits may take place at any portion of the fundus, but most often they appear first near the periphery and thence extend toward the posterior pole. Their color is yellowish-white or gray, and often quite dull, and their size and shape are subject to many variations. They may be very small at first, not larger than a mustard seed, but as the disease advances they are apt to increase in size and to finally coalesce, forming larger and more irregular patches.

A syphilitic form of the disease begins most often by spots of exudation at or near the posterior pole, thence extending by increase of size and number toward the periphery. The spots do not coalesce, and are surrounded by a pale red border. But unless the patient's history confirm the diagnosis, the syphilitic nature of any case can not be fully determined.

In later stages, the absorption of the exudations begins and progresses until not only they have disappeared, but until the choroidal structure in which they were lodged becomes atrophied and patches of the glistening white surface of the sclerotic are seen. Around these white patches a dense border of pigment is collected, and the retinal vessels are seen crossing the patches themselves.

That the exudations are not in the retina is made evident by the fact that the retinal vessels can be seen clearly and uninterruptedly passing over them, and furthermore, in the intervals between the spots the retina appears perfectly normal. But, although this disease is described separately, it is scarcely necessary to observe that if it is at all severe, the retina and iris both become implicated, and atrophy of the retina and optic nerve are the result. Opacities of the vitreous, either fixed or floating, are not an infrequent accompaniment of the disease.

The **tumors of the choroid** are sarcoma and carcinoma, but the ophthalmoscope does not aid in distinguishing between them. At the outset of the disease a small spot or elevation may be seen in the choroid. This gradually increases in size, and advances toward the vitreous, causing changes in the retinal structure. Soon an effusion of serum takes place behind the affected portion of the retina, causing detachment of the latter. The detached portion of the retina can be seen in its wave-like folds, trembling with each motion of the eye. This usually obscures the tumor from view, and the ophthalmoscope does not disclose it again until it has considerably increased in size. Often the lens or the vitreous humor becomes hazy or opaque, early in the disease, and this prevents any clear observation.

Coloboma, or fissure of the choroid, is often accompanied by fissure of the ciliary body and of the iris, and sometimes even of the lids; but it may exist independently of all these. The optic disc may also be included in the fissure.

Together with the fissure of the choroid there exists a bulging backward, or **staphyloma of the sclerotic.** The fissure is at the lower part of the fundus, and is of congenital origin. It appears as a gray or whitish figure of varying width, extending from the optic disc to the ciliary body, and its color is due to the partial exposure of the sclerotic. Its size, shape and color are dependent upon the extent to which the choroid is deficient. The margins of the figure are clearly defined and usually pigmented, and the course of the retinal vessels, as they cross, is curved or twisted. More or less of the attenuated choroidal structure is usually present between the margins of the fissure, and can be detected.

Tubercles of the choroid may be observed in the eyes of tuberculous patients. They are situated in the region of the optic disc, and appear as pale yellow or pale rose-colored spots from three millimeters to five millimeters in diameter. The larger ones are somewhat elevated above the level of the choroid. They have a

slightly reddish tinge about their margins, but do not present a very marked contrast to the surrounding normal color. Their slight elevation causes the vessels to curve in passing over them. Very exceptionally they are slightly pigmented around their borders. The retina remains normally transparent.

Rupture of the choroid follows injuries to the eye or to the head, such as blows. Hemorrhage and cloudiness of the vitreous usually follow; but after these are sufficiently absorbed, the presence of one or more whitish streaks may be detected in the choroid, and generally at or near the outer side of the optic disc. The edges of the streaks are clear and sharp, and usually bordered with pigment. The retina often passes intact over the rupture, as shown by the uninterrupted course of its vessels. The course of the rupture is usually vertical, and it may be straight or curved. It is more common to find it consisting of two or more lines of separation than of only one.

The choroidal coat undergoes some very marked changes in myopia, especially in myopia of a high degree. In the vicinity of the optic disc, generally at its outer side, the choroid becomes atrophied in the form of a crescent. This is called the **myopic crescent,** and is frequently accompanied by thinning and bulging backward of the sclerotic. The crescent is a white, reflecting surface, and is caused by the sclerotic shining through the atrophied portion of the choroid. Its size may vary much; it may be a very small white arc, or may extend entirely around the disc in the form of a broad white girdle. In the latter case, the term crescent does not apply. Small patches of pigment sometimes dot its expanse. The whiteness of the crescent, or girdle, causes the optic disc to appear abnormally pink by contrast.

But instead of a sharply defined crescent at the outer side of the optic disc, or a girdle encircling it, the atrophy of the choroid may take very irregular forms. It may shade off into the surrounding healthy choroid so as to have no distinct outline, or it may have branches.

Hemorrhagic effusions may be wholly confined to the choroid, or they may escape through the retina into the vitreous. They may pass backward between the choroid and the sclerotic. Hemorrhages into the choroid may usually be recognized as dark, irregularly shaped, red spots, over which the retinal vessels pass uninterruptedly. Sometimes if the blood spots are very dark, it is impossible to determine if the vessels really pass over them or beneath. They are apt to persist a long time, and some pigment

may become deposited about them; but during the process of absorption they become paler and of a yellowish hue; and, if small, may leave no trace behind.

Detachment of the choroid from the sclerotic is somewhat analogous to detachment of the retina, in its appearance; but it may be distinguished from it by the fact that it does not tremble with the motions of the eye. The retinal vessels may also be distinctly traced over its surface. The protrusion is ovoid in form, and distinctly seen in the erect image. Its surface is smooth and the choroidal vessels can be seen close beneath it.

If the detachment is caused by an effusion of blood, the color of the tumor is dark red; but if caused by serum it is of a yellowish tint. The retina covering the surface of the protrusion may also become partially detached and complicate the appearance.

The **ciliary body** may be regarded as the central portion of the uveal tract and is a continuation of the choroid. It is chiefly concerned by its muscle in the act of accommodation, and is mentioned in this connection on account of its complication in the iritic and choroidal diseases.

Irido-cyclitis. or inflammation of the iris and ciliary body, is caused often primarily by cyclitis, but generally springs up in connection with iritis, or with choroiditis. It frequently arises from injuries, such as wounds in the ciliary region, a dislocated lens, or a foreign body in the eye.

It may also be sympathetic from the other eye; when so arising its principal symptoms are great tenderness on pressure over the ciliary region, with pain. This tenderness on pressure is not present in iritis. It is accompanied by turbidity of the aqueous and vitreous humors, loss of accommodation, photophobia and lachrymation, impairment of vision, a zone of vessels around the cornea, and an increase of tension.

It is an extremely dangerous and insidious disease, much resembling iritis, and often steals on quietly without marked subjective warning, and hence is unnoticed until beyond hope. Of all the inflammations of the eye, there is none over which the surgeon has less control with materia medica. A comprehensive knowledge of the subject is all-essential; an error in diagnosis or a vacillating delay reaps a terrible punishment.

As to the method by which this inflammation is transmitted from a companion eye, pathology reveals little that is practical. It is enough to know that the nervous relationship existing between the eyes

is sufficient to transmit to a previously sound companion eye an inflammation originating in an injured eye, this transmission being effected so incomprehensibly as often to be unrecognized until the injury is hopelessly done. These effects, known interchangeably by the terms sympathetic irido-cyclitis, sympathetic irido-choroiditis, sympathetic ophthalmitis, and **sympathetic ophthalmia,** constitute an extremely dangerous disease. Its pathology, as far as known, is simple, consisting of an irritation causing an exudation of plastic lymph capable of speedy organization, and in such process gluing together the delicate mechanism of the eye; or the exudation may assume a serous or purulent form, and the eye totally break down. There are generally prodromal symptoms giving warning. When present these are known as symptoms of **sympathetic irritation,** and may be embraced as irritation and slight injection of the previously sound eye, neuralgic pain, slight photophobia and lachrymation, with speedy fatigue of the eye when used at near or fine work. An ophthalmoscopic examination of Descemet's membrane, especially to note if there are any fine deposits thereon, and to detect any fleeting cloudiness of the aqueous humor, should not be omitted at this stage of the disease. When fully developed in a typical case, the globe has a pinkish appearance from the sclerotic injection, with a well-marked rosy zone of vessels, indicating internal congestion, and is tender to the touch. The iris is adherent to the anterior lens capsule throughout the pupillary margin, causing an infundibuliform appearance peculiar to this trouble. The disease extends back to the fundus, the lens becomes opaque, the tension of the globe changes and vision is lost.

There is no warning by which the approach of this trouble may be declared with certainty, but the causes most likely to produce it in a companion eye may be found in injuries involving the ciliary region, penetrating wounds from blunt points being especially dangerous; in foreign bodies penetrating the globe and passing from the sight, or if remaining in view, can not be removed; wounds near the cornea or in it, involving the ciliary region, and especially when in the process of repair of such wound a portion of the iris, of the ciliary processes, or of the anterior lens capsule, becomes entangled in the cicatrix; and in degenerative changes which have taken place in an eye in which vision is already lost from some cause other than suppuration, eyes lost by suppuration being least likely to cause this trouble.

It avails nothing to report "cures" of eyes so injured as to be embraced in the above classes, for so far as can be seen such cases are

cured; no one can authoritatively say they are not cured, and yet after months or years, without the least disturbance in the injured eye, or any manifest sign of any morbid change whatever, vision in the companion eye may slowly fail, or with consuming inflammation quickly go out forever. Neither does it avail anything that any physician of any school of therapeutics "cures" a case of this kind after another physician of any school has declared it "incurable," because the latter has no knowledge entitling him to such a dictum, and the former does not know if the disease is forever quieted by his medicine, or only lies dormant from its peculiar nature. All that one is warranted at the present time in saying is, that the experience of oculists permits the assertion that it is almost certain that sympathetic irritation or ophthalmia will not arise after all nervous connection has been severed by the removal of an irritating globe or remnant, provided there have been no sympathetic symptoms already manifest; and if there has been sympathetic irritation, sympathetic ophthalmia will, most likely, be prevented by such removal.

Several operations have been proposed to obviate this removal and sequent disfiguration, and variously named. That any one of them would be eagerly seized upon were it efficient, admits of no discussion. But inasmuch as all fail to permanently sever all nervous connection between the two globes, they have proved uncertain, and their consideration is unnecessary.

The danger of the supervention of sympathetic ophthalmia is generally considered at the minimum after injury up to the seventh or eighth day; after that period until about the thirty-eighth or fiftieth day at the maximum. But there is no set time, and it may appear soon after an injury, or delay weeks, months or years.

It is evident that the judgment and skill of a surgeon is severely tried to determine whether or not to leave an injured eye, especially when it retains any sight. Hence in a case of threatened or possible sympathetic irritation (the stage preceding sympathetic ophthalmia), when the practitioner can have the immediate supervision of a patient so that the first approach of sympathetic ophthalmia may be noted, or when the patient is of sufficient intelligence to appreciate the nature and danger of the trouble, which should be fully explained, the injured eye may be allowed to remain if there is still vision present; but where the reverse is the case, and all sight in the injured eye is lost, the danger to the uninjured eye of entire loss of sight from the presence of the irritable eye should outweigh all other considerations, and the injured eye be at once removed. It should ever be borne in

mind, however, that risks are taken, varying in degree, in permitting the injured eye to remain, and the first symptoms of irritation should warn that they must be met without delay.

For local treatment, when the disease is primary, complete rest, protection, cold or heat as is best borne, atropine, and the remedies seemingly indicated, may be tried, a careful watch being kept on the companion eye for the first symptoms of irritation. Fortunately the idiopathic form is not as dangerous as that arising from injury.

Myosis. Contraction of the pupil is associated with diseases of the globe, and frequently calls attention to a more serious lesion of the deeper structures. This symptom often demands for its solution an intimate acquaintance with the higher branches of ophthalmology, and diseases in which it occurs should not be lightly regarded. Unconnected with the more serious classes of disease, contraction of the pupil is comparatively seldom seen.

Mydriasis.. Dilatation of the pupil accompanies lesions of the brain or spine, and is often a guide to ravel hidden and remote diseases. Like myosis, a thorough familiarity with eye troubles is essential to comprehend its monitions. Unlike myosis, it is associated with minor complaints at times. As it is often associated with serious organic defect, however, watchful care should be exercised until a conclusion as to its danger can be formed.

Irido-choroiditis. Inflammation of the iris and choroid is caused by an extension of inflammation from the iris, and the reverse.

The symptoms are those of iritis mainly, but exaggerated in degree. The vitreous becomes clouded, and there is a contraction of the field of vision not explained by iritis. The disease is most frequently the result of a previous oft-recurring iritis, where the chambers of the eye have become separated by exclusion or occlusion of the pupil, or the iris is being dragged on by synechiæ. Eyes are often lost by the disease, and sympathetic ophthalmia may result and the companion eye be endangered or lost.

When occurring with iritis, it requires the same treatment. Iridectomy is the most valuable remedy for severe cases.

The remedies most suited to diseases of the uveal tract are as follows: In the first stages, when there is heat and dryness of the eyes, aconite will be found useful. It is particularly valuable after surgical operations, when there is restlessness with constant turnings of the patient; seeming tendency to an inflammation. All the symptoms of the patient are accompanied by much general febrile excitement, denoted by quick pulse, dry, hot skin, thirst, etc. There is also a

direct indication for its use when there is marked ciliary congestion, with contracted pupils, and severe throbbing pains.

Alium cepa is a valuable remedy when pains produce intense suffering or restlessness. The mother tincture should be given in five-drop doses.

Arsenicum is called for by burning pains. The parts burn like fire. Great anguish and restlessness are present; the patient has intense thirst, drinking little and often. All the pains are worse at night and after midnight; better from warm applications. The pains are aggravated by light and by moving the eyes. There is photophobia, lachrymation, and great prostration of mind and body.

Arnica is called for where there is hemorrhage and ecchymosis from blows and wounds of any description.

Asafœtida for severe boring pains above the eyebrows. The pains are also throbbing, beating, boring, or burning in character in the eye, over or around it. Highly useful in syphilitic iritis, and after the abuse of mercury. The pains are usually from within outward, and are relieved by rest and pressure. It is also particularly adapted to nervous, hysterical persons with hypersensitiveness of the whole system.

Aurum has been successfully used in syphilitic iritis, and after the abuse of mercury and potash. The pains indicating its use are dull or burning in character, compelling one to close the lids occasionally. They are worse in the morning, and ameliorated by the application of cold water.

It will also be found a valuable remedy in cases of syphilitic iritis, where there is great depression of spirits, with tearing, pressing pains, seemingly deep in the bones surrounding the eye, and aggravated by touching.

In the early stages belladonna will sometimes be useful. It is particularly suited to plethoric persons, and those of a stout, full habit.

Indications for its use are as follows: Photophobia; sharp pains in the orbits, extending to the brain; the pains appear suddenly, and cease as suddenly; there is dimness of the vision; the eyes are red with much congestion; bright redness of the vessels.

Throbbing pain in the head and eye, and flushed face, things looking red, sparks of fire passing before the eyes, are symptoms also relieved by this remedy.

In inflammation due to rheumatism, and in the serous forms generally, bryonia is a useful remedy. The symptoms controlled by it

are a sensation of pressure from within outward in the globe of the eye. Sensation of soreness and aching in the ball and around it. Sharp, shooting pains in the eyes, extending into the head and down into the face; or pain as if the eye were being forced out of the socket. All the pains are aggravated by moving the eyes in their sockets. The eye symptoms are aggravated by warmth, and are generally worse at night. Patient is exceedingly irritable at night, not so much so during the day. The head aches as if it would split open.

In periodical supraorbital neuralgia, cedron is indicated. The pains are sharp and shooting, starting over the eye and extending along the branches of the supraorbital nerve.

Calendula is valuable in a class of cases somewhat similar to those where arnica is usually prescribed.

Chamomilla relieves severe ciliary neuralgia in scrofulous children.

When dependent upon or continued by loss of vital fluids or malaria, china will afford much benefit. The pains are variable, but show a marked periodicity.

Cimicifuga is indicated under these conditions: Rheumatic iritis, with intraocular tension and much pain; intense and persistent pains in the eyeballs, of a dull, aching, sore nature; pain in the center of the eyeballs.

Cinnabaris has been used very successfully in condylomatous excrescences on the iris, edge of the pupil, or edge of the lids. Particularly valuable in syphilitic iritis.

Colchicum is well adapted to rheumatic cases, with great soreness of the eyeballs. Violent, sharp, tearing pains in the eye, around the orbit.

Cutting pains around the eye have been controlled by colocynthis. Pains relieved by it are quieted by pressure.

Conium is well suited to the debility of old people. Burning heat in the eye is well met by it also.

Euphrasia has been used in rheumatic iritis, with constant aching, and occasional shooting pain in the eye. The lachrymation is profuse, the tears acrid and excoriating.

Gelsemium acts well in serous diseases of the uveal tract.

Hamamelis is a valuable local application in traumatic iritis, and may be used internally at the same time. Hemorrhage into the anterior chamber may be hastened in its absorption by its use also.

Hepar sulphuris is one of our most valuable remedies. In all cases where suppuration has taken place, or is inevitable, as in kerato-iritis, or suppurative iritis, its administration is called for. The pains are

throbbing, pressing, or aching in character, aggravated by cold and relieved by warmth. Much photophobia, with swollen and sensitive lids. Absorbs pus in the anterior chamber. Adapted to scrofulous persons with enlarged glands, every cut or wound suppurating; also to the system after the abuse of mercury.

Kali iodatum is a valuable remedy in choroiditis, or in acute or chronic irido-choroiditis. It also follows well in syphilitic iritis after the patient has been drugged with mercury, or when secondary symptoms accompany the eye inflammation.

Lachesis is indicated when there is much pain in the eye, with sharp pains in the upper jaw and teeth, with complaints of suffocative feelings. Stitches as from knives in the eye, the sensation coming from the head. The eye complaints are worse after sleeping. Pains rapidly change from the eye to other parts of the body and back again.

The preparations of mercury have long and successfully been used. They are all valuable, especially in the syphilitic forms. The symptoms comprise a great variety, and the choice of a particular form will depend upon the general characteristics.

In the syphilitic and choroidal forms of these troubles mercurius corrosivus and the iodides are the most effectual.

After exudations have taken place from the iris, which appears discolored, or the area of a pupil is covered by a film with a tendency to posterior synechiæ, no remedy is better to promote absorption. Hypopyon or condylomata yield to its influence.

While the eye symptoms may call for this remedy, we oftener find general characteristic symptoms in connection with them. These are such as diseases of the glands, acute or chronic; cold clammy sweat on the thighs and legs at night; salivary glands greatly swollen, with excessive secretion of saliva and fetid breath; greyish ulcers on the inner surface of the lips, cheeks, gums, tongue and soft palate; eruptions on the skin; nightly pains in various parts of the body. Aggravations are from warmth, at night, from rest, and in damp weather.

Nitric acid is especially useful in treating syphilitic or gonorrhœal troubles. It also follows well after the abuse of mercury. While not strictly applicable to many eye diseases, it is adapted to the treatment of affections arising from suppressed syphilis, and to secondary affections of syphilis in broken or cachetic constitutions.

Nux vomica is an auxiliary remedy, especially adapted to people of a malicious, irritable temperament, and to those who make great mental exertions.

Pulsatilla relieves in characteristic subjects.

The symptoms are all worse toward evening; relieved in the open air, worse on returning to a warm, close room. The form of symptoms is very changeable; worse one moment, better the next, or at longer intervals. Sluggish circulation manifested by constant chilliness, coldness and paleness of the skin; disorders of digestion and menstruation.

Rhus toxicodendron is a remedy especially valuable in suppurative inflammation of the iris, the latter involving, or showing a strong disposition to extend backward and involve the rest of the uveal tract.

Iritis occurring in rheumatic subjects, or arising from exposure to cold is well met. The pains are worse at night, and relieved by warm applications; also worse before a storm and in damp weather. Rheumatic pains that affect any part of the body, aggravated by rest, and relieved by motion.

Silica promotes a tendency to absorption, and will be found to exercise control wherever this point is desirable.

Spigelia is useful where the pains are sharp and shooting, or severe, pressing and jerking, and radiate from points around or in the eye. The pain is much worse from moving the eye in any direction.

Iritis in scrofulous subjects will often be benefited from the use of sulphur. It is useful in chronic cases, and when the pains are sharp and sticking, like pins sticking in the eyes. Useful after suppressed eruptions.

Thuja is indicated in syphilitic iritis with condylomatous excrescences upon the iris. The pains are ameliorated by warmth.

SECTION EIGHT.

Glaucoma is one of the most dangerous of eye diseases. The causes are probably oftenest from heredity, mental emotions, such as prolonged grief, or any influence on the fifth nerve, and direct irritation of the ciliary nerves. Retinal hemorrhage is an indirect cause. It is also secondary to other diseases.

The almost certainty that badly or neglectfully treated, hopeless blindness will ensue, has stimulated ophthalmologists to its thorough study. Hypermetropic eyes are most liable to its inroads, and females at and about the menopause are highly susceptible, an attack on either eye almost certainly extending to its companion.

A fully declared glaucoma is a rare form of the disease, and may be confounded with a severe bilious attack, or a brain trouble until too late for advantageous aid. In this form its onset is so furious and of such an acute type of inflammation that it should not be overlooked. In the chronic form prodromal symptoms may be shown, such as a rapid increase of any existing presbyopia; colored rings around a light, the latter appearing as when seen in a foggy atmosphere; intermittent obscurations of sight, the intervals or periods of remission lasting days or months; more or less neuralgia, combined with the ciliary form; a variable slight increase of the intra-ocular tension, and a contraction or narrowing of the visual field, with dimness of vision.

Immediately before an acute attack these symptoms are intensified; it then bursts forth with the addition of severe headaches and terrible ciliary neuralgia, cloudiness of the aqueous and vitreous humors, dilatation and sluggishness of the pupil, which may be filled with a greenish reflex (whence the name of the disease) photophobia, lachrymation, and conjunctival congestion, fever and vomiting, and clouded cornea, the iris being jammed down against the cornea until the anterior chamber is obliterated. The distinguishing symptom is never lacking, the increased tension. Should a view of the fundus be obtainable, an unusual thing owing to the turbid condition of the humors and media generally, there will be found pulsation of the arteries, a swollen beaded appearance of the veins, slight retinal hemorrhage, and most likely the cupping of the optic disc fully described in Section Ten.

But the acute attack is rare compared with the chronic form in which the disease generally invades the eye. A rarer form still is the lightning glaucoma (glaucoma fulminans), which is an intensified acute attack, concentrating its energy into a few hours. Under the chronic form the prodromal symptoms are usually mild, nearly always overlooked, and the disease crawls on, becoming hopelessly incurable, or bursting into the acute form. The narrowing of the visual field may be the only symptom noted by the patient, or perchance an increase of an existing presbyopia, necessitating frequent visits to the optician to change glasses. Any one of the symptoms should be regarded as suspicious. No case of eye disease, of a nature not thoroughly disclosed, should be dismissed without ascertaining the eye-tension, with a searching glance for this subtle trouble. A nebulous cornea, a dilated pupil, any uncertain symptom, and above all, a staphylomatous globe, may conceal this disease in ever-shifting form,

which hurrying on to the absolute form, renders the globe as hard as stone, the pupil dilated, the lens opaque and green, the cornea dull and insensitive, and the anterior chamber shallow or obliterated.

It is not surprising that a physician hastily summoned to a patient who is vomiting and loudly complaining of terrible hemicrania, and who shows no more injection of the eye than emesis produces, should think of many diseases before this one, especially as the patient may lay light stress on his disordered vision.

The age at which glaucoma is found, it being almost always a disease of middle life, may assist in the diagnosis, though cases are not infrequent at an earlier age.

Care should always be used in the instillation of atropine into the eyes of patients over forty years of age; great care if there is detected the slightest tendency to glaucoma. A solution similar in strength of eserine or of pilocarpine may be used. Cases of an acute nature may do well under local remedies, but they avail little in chronic cases.

The general health should be enquired into, and suitable instructions given, moderate use of the eyes enjoined in recurrent attacks, cheerful surroundings, and the tonics of air, sunshine and cheerful company not neglected.

Among internal remedies used at the outset and as aids to other treatment, belladonna has been found of use in relieving the flushed face and throbbing headache with sharp pains. The pupils are dilated, conjunctiva congested, with a general dry feeling, and much photophobia.

Bryonia alba may be given when the eyes feel sore to the touch, and are generally worse on motion. Sharp, shooting pains through the globe may also demand this remedy.

Cimicifuga is valuable for the wandering pains which often change into other portions of the body.

Colocynthis has been used where the pains are better on pressure, but of a sharp, stitching nature.

Gelsemium is one of the most valuable of the remedies in this trouble, being often palliative of the severe pains, and seemingly exercising a curative influence on the neurotic character of the disease.

Phosphorus is useful in clearing up the vision after an iridectomy has been performed.

Spigelia has been found more valuable than any other one internal remedy for the alleviation of the sharp, shooting, and sticking pains which accompany this disease. These pains are worse on motion and at night.

Others will be suggested by their concomitant symptoms. Reliance, however, should not be placed on internal remedies alone, for in nearly all forms an iridectomy is sooner or later indicated, and is then the only remedy known.

SECTION NINE.

The **lens** has diseases of only one character to be considered. Strictly speaking, the term **cataract** should be limited to an opacity of the lens, though the term is applied to opacities of the lens capsule as well. There are therefore two general classes of cataract, the capsular and the lenticular.

Capsular cataract is an opacity of the lens capsule, which generally encroaches on the area of the pupil. It has a whitish appearance and seldom occurs without the lens itself having been previously involved.

The anterior capsule is more frequently affected than the posterior. The trouble is not so much in the capsule itself as on its inner surface, where, with the oblique illumination, crystals of cholesterine or chalky concretions may be seen.

Lenticular cataract may be divided into four varieties: the soft, the cortical, the hard and the zonular.

Soft cataract occurs among infants and young children and is often congenital. Dilate the pupil with atropine; the lens shows a bluish-white opacity which is usually uniform and free from striæ. With the ophthalmoscope the opacity will be found to reach from the center of the lens to its circumference and no portion of the fundus will be visible. Occasionally, opaque whitish spots are noticed beneath the capsule.

Under the head of soft cataract, **traumatic** cataract may be mentioned as sometimes analogous in appearance. If an injury to the lens is extensive the aqueous humor prevades its whole substance and renders it opaque. In slight injuries only a small and irregular portion of the cortical substance is involved. The history of the case will almost preclude the possibility of a mistake in the diagnosis.

Before fully formed, the **cortical** cataract appears as a series of striæ running from the circumference of the lens toward its center. These striæ are often situated in the posterior substance of the lens, but as the cataract advances, they become white, increase in breadth

and finally occupy the whole lens. Dilate the pupil with atropine, and the opacity will appear quite uniform but marked with pearl-like bands, and perhaps of a yellowish tint at the center. But with the ophthalmoscope, it will be noticed that the margin of the lens allows a few rays of light to pass from the fundus, the red reflection being seen. The central portion of the lens appears opaque and dense, surrounded by a dim reflection from the fundus. In the soft cataract, no striæ or colored reflection are seen.

Senile or **hard** cataract seldom affects a person under forty years of age. It first appears as an amber-colored opacity, most marked at the nucleus, the cortical substance remaining comparatively unaffected. The amber-colored center is the characteristic feature throughout the course of its formation. In the earlier stages, if the pupil is dilated with atropine, small opalescent striæ may be seen extending inward from the circumference, and as the cataract advances, these become more apparent. The ophthalmoscope shows the circumference more transparent than the center even in the latter stages. Spots of fatty epithelium are often observed beneath the inner surface of the capsule.

Zonular cataract is usually congenital, and most often occupies layers of the posterior cortical substance of the lens, and is most dense at the axis. Dilate the pupil with atropine, and unless the case is far advanced, the ophthalmoscope clearly reveals a portion of the fundus through the circumference of the lens. Even a dim reflection of the fundus may be seen through the denser portions. The opacity appears, by oblique illumination, as a whitish-gray film apparently upon the posterior lens capsule. Sometimes striæ radiate from the central portion, but the circumference of the lens is often completely transparent. This form of cataract may be progressive or may remain stationary for many years.

The lens may be either partially or completely displaced, and in almost any direction. In partial **dislocation,** if the pupil is well dilated with atropine, the change in the position of the lens may be noted by either oblique illumination or by the ophthalmoscope. Using the ophthalmoscope by the direct method, the edge of the lens may be seen as a distinct, dark, curved line lying over the back-ground of the fundus. Not only this, but if the lens is so far dislocated laterally, as to leave a portion of the pupil unoccupied, a distinct erect image of the fundus can be seen through that portion of the pupil, and the part of the fundus thus seen will be very hypermetropic.

Complete dislocation of the lens into the anterior chamber can scarcely be mistaken even when the lens is quite transparent. If the dislocation is backward into the vitreous, with the ophthalmoscope its location can readily be ascertained. It will appear nearly natural in outline, darker in color, occupying the lower portion of the vitreous while the head is erect. Using the oblique illumination, no reflection from the anterior capsule is apparent. When the lens lies partially across the pupil, it acts as a prism, and a double image of the fundus may appear; but when it is entirely without the axis of vision, the eye becomes intensely hypermetropic, and the details of the fundus appear very small.

Success in the medication of the lens is as yet problematical, though to various remedies are attributed powers in effecting changes. At present the subject lies almost wholly within the domain of operative surgery.

SECTION TEN.

The **optic disc,** or papilla, is frequently the seat of pathological changes, and its appearance differs much in the various affections.

Hyperæmia of the disc accompanies hyperæmia of the **optic nerve,** and if confined to one eye, an advantage may be gained by comparison with the healthy eye.

The disc becomes much reddened, its vessels are fuller and its margins not clearly defined owing to a haziness which extends over into the retina. The vessels of the retina are generally more or less enlarged, and often the whole fundus, including the disc, is of a uniform red or scarlet hue. In the latter case, the position of the center of the disc can be determined only by the position of the central vessels.

In **optic neuritis,** or inflammation of the nerve, the phenomena in the disc differ with the origin of the disease, and its successive stages, but in the earlier stages the following symptoms generally present themselves: The disc appears larger than in health, and is red, swollen and somewhat œdematous. Its surface is convex instead of concave, its margin hazy and dimly defined. The appearance of the surface and margin of the disc is often described as woolly, and is due to hypertrophy of its connective tissue. The vessels from the

retina can not be traced beyond its margin, and their exit from the eye is frequently lost to view. New vessels often become developed upon the surface of the papilla, and not unfrequently its surface and vicinity are the seat of numerous blood extravasations; both of which causes render it very red and vascular. The disc is prominently elevated and can be seen at some distance from the eye in the erect image. Owing to the firm and unyielding nature of the scleral ring which encloses the nerve's extremity, the swollen and infiltrated nerve presses upon its own vessels and obstructs the circulation. As a result the retinal veins are more or less engorged, dark and tortuous, while the arteries are much contracted and at times scarcely distinguishable.

Severe cases of optic neuritis are usually followed by more or less complete atrophy of the papilla and nerve, and this constitutes the later stages.

In **anæmia** both eyes are equally affected, each disc being unnaturally white. The retina and choroid are also wanting in color. The eyes do not light up well. The general state of health in which the patient is found helps to explain the anæmic state of the eyes.

The paleness of anæmia of the disc may be distinguished from the paleness of atrophy by observing that in anæmia the fundus also is pale, but in atrophy it remains red because the choroidal vessels are normal in color. Neither is the paleness of the anæmic disc so striking as that of the atrophic, owing to its lack of contrast with the surrounding fundus. In all stages of anæmia, although the amount of blood is small in both the central arteries and veins, these vessels can be distinguished from each other. In the earlier weeks of atrophy the central veins are dilated and the arteries small; but later, both sets of vessels are reduced in size and number and finally become undistinguishable from each other. It not unfrequently happens that no vessels can be traced over the white expanse of an atrophied disc. Perhaps a single artery or vein may remain, though it is generally destitute of branches.

There are two classes of **atrophy of the optic papilla**, the primary or progressive, and the consecutive. The appearances of the disc in atrophy may be enumerated as unnatural whiteness, decrease in calibre of the retinal vessels, the veins diminishing in size somewhat later than the arteries, and a peculiar excavation of the disc itself. Sometimes the whiteness is very great, and in other cases the color is bluish-white. The small nutrient vessels upon the surface have generally disappeared, and this aids in producing its unnatural

whiteness. The latter is especially marked in cases of primary atrophy in which the outlines of the disc though sometimes irregular, are clearly defined.

Atrophy consecutive upon optic neuritis is usually for a long time distinguishable from other kinds. The papilla remains swollen, and its outline indistinct. Its color is of rather a dull grayish-white; but after a time distinctions become lost, and it assumes the same appearance as the other varieties. In most cases of atrophy of the disc both eyes are affected, but not always to an equal extent.

Cupping or excavation occurs in three varieties, known as the physiological, the atrophic, and the glaucomatous.

The first or **physiological cup,** is a congenital **excavation.** It never involves the whole disc, is usually very small and shallow and generally confined to the central portion, though quite often displaced. The walls are in most cases slightly inclined from the center to a higher level. Exceptionally they are steep or irregular, or the cup may be funnel-shaped. As the retinal vessels enter the disc, they curve more or less acutely as they pass the margins of the cup. The whole fundus moreover looks healthy and cheerful, and there are none of the symptoms accompanying the other diseases.

In the **atrophic cup** there is loss of nerve fibers, blood vessels, and sometimes connective tissue. The blood vessels are not usually all lost, but those which remain are altered in size and appearance. The excavation is shallow, but involves the whole surface of the disc. It is also deepest at the center. In the beginning of atrophy the whiteness is very bright, and occupies a portion of the disc near its center. Later, this whiteness extends and occupies the whole surface of the disc quite up to the sclerotic ring, and the latter stands out very distinctly. The ultimate color of the disc is apt to be bluish or grayish white. The shallowness of the excavation and its gradual inclination from center to edge cause no very marked curve or displacement of those vessels which remain. They pass over its edge with little or no appreciable curve, and no part of them is lost to view.

The **glaucomatous cup** is usually very deep, and occupies the whole surface of the disc. In its early stages the walls may be steep, straight and only moderately deep, but as the disease progresses the cavity deepens and the edges of the disc overhang its sides. In the first case the continuity of the central vessels may be traced, though they necessarily describe a very sharp curve on passing the edge; but when the sides become excavated laterally, parts of these vessels are lost to view. Vessels from the retina upon reaching the margin seem

to abruptly break of, but remnants of them may again be dimly seen near the center of the floor of the excavation.

A shadow surrounds the scleral entrance of the central retinal artery (porus opticus) in the form of a ring, and changes with the movements of the ophthalmoscope. This shadow is cast by the walls of the excavation, and was formerly the cause of an optical illusion, and cupped discs were regarded as prominent ones. Deeply cupped discs have a mottled appearance, the result of atrophic changes and the manner in which the light falls upon them; the usual color is gray or grayish-white; it may be greenish or even very white.

Another characteristic appearance in the glaucomatous cup is the so-called **parallax of glaucoma.** This is apparent while using the indirect method of examination and slightly moving the objective from side to side. As the objective is moved, both the floor and the margin of the excavation move too, but the latter much more rapidly than the former; and it requires no great movement of the lens to cause the margin to move some distance across the bottom of the excavation. Arterial pulsation, so often noticeable in glaucoma, is another distinguishing point, but the characteristic displacement of the vessels, the abrupt sides of the cavity, and the other points already described, can hardly fail to show the nature of the glaucomatous cup. Partial cupping of the disc has been sometimes observed in glaucoma. It is recognized by the same marks as the other forms.

It is not unusual to find quite a **deposit of pigment** along the edge of the optic disc, but very rarely does pigment become deposited within the limits of the disc itself. Cases have been reported, however, in which marked pigmentation of the disc occurred. This abnormal change has usually followed some severe accident to the eye, and is due to the escape of coloring matter from the blood.

In most cases of retinitis the disc is inflamed also, and in all cases of optic neuritis of any extent, the **retina** is involved. The concurrence of inflammation in both of these structures is known as **neuro-retinitis.**

Acute parenchymatous retinitis presents these ophthalmoscopic appearances: The fundus of the eye is uniformly scarlet and the outside of the optic disc lost. The central artery may remain normal, but the veins are enlarged and unusually tortuous. Blood extravasations, of varying form and extent, are usually scattered over the expanse of the retina. An effusion of serum or lymph renders the retina more or less swollen and œdematous. There is a hazy look about the fundus, in most cases, owing to the retinal infiltration.

If the disease assumes a more chronic form, the inflammatory exudation causes the disc, as well as the surrounding fundus, to look opaque, and the character of the exudation determines the color of the opacity. An opacity resulting from serous effusion is pale and of a grayish or grayish-pink color. An exudation of lymph causes an opacity which is nearly white. If the exudation occupies the external retinal layers, the retinal vessels will not be obscured; if the internal retinal layers are involved, the vessels will be hidden to an extent depending upon the nature and size of the exudation.

Inflammation of the vitreous body, with sequent haziness, is an accompaniment of acute retinitis, especially if the internal layers are affected; this may obscure to a considerable extent the real appearance of the retina. The spots of blood extravasation vary in color, size and appearance with the depth at which they are situated, the length of time they have existed, and whether they originated from the arteries or from the veins. These will be further described under retinitis apoplectica. Inflammatory exudations may occupy the whole or a part of the retina, and may be scattered about in spots or in clusters of spots.

Serous retinitis is not easily recognizable with the ophthalmoscope. It is characterized by a delicate, uniform, bluish-gray or greenish opacity, which appears like a cloud over the surface of the retina. The infiltration of serum is usually most observable about the disc, and gradually shades off toward the periphery of the retina. The periphery may be entirely free from any infiltration.

On account of the thinness of the retina at the yellow spot the opacity at this place is less marked; as a result there is an apparent increase of redness at this point, owing to the reflection from the choroidal vessels. The retinal arteries are normal while the veins are usually congested, dark and twisted in their course.

Retinitis albuminurica or **nephritic retinitis** occurs during the progress of Bright's diseases of the kidneys, or precedes and is recognized before any of the other symptoms of the latter malady are apparent. The pathological appearances of the retina are thought by some to be constant and peculiar; but before the disease is fully developed the changes which are observable may all be included under the forms of inflammation already described. The disc is hyperæmic and its outline indistinct. There is serous infiltration in the vicinity of the disc and this occupies quite a portion of the surrounding retina. The arteries are normal at first, and the veins larger, darker, and more tortuous than usual. As the disease ad-

vances the above symptoms become more marked and the optic disc may even become swollen and prominent. Now the characteristics of the disease begin to appear. Hemorrhages are the first and these occur early in many cases. Sometimes they are about the first thing noticed and the most usual position is in the vicinity of the disc and macula lutea. Small spots, usually whitish though sometimes yellow or gray, begin to form in the retina around the disc. These develop in size and number, and finally coalesce into one large patch, or, as is more usual, form a broad white belt around the disc. This belt is usually separated from the disc by a space which is occupied by grayish infiltration. At the same time whitish dots, or small starlike figures, are noticed in the region of the macula lutea. These also may run together and perhaps join the belt.

These spots around the macula lutea, together with the whitish belt surrounding the disc, are the most characteristic symptoms of this form of retinitis.

It is often possible to discover Bright's disease before much evidence of it can be gathered from the urine. In cases where it is least expected, the observer has sometimes to announce to the patient the true nature of his malady, and confirm his diagnosis by an examination of the urine.

The spots which appear in the region of the optic disc and the yellow spot are due to fatty degeneration of blood and of connective tissue. All of the symptoms enumerated differ much in character and degree in individual cases. Similar spots and marks are sometimes present in other forms of retinitis, especially in that form due to constitutional syphilis; but the spots are much paler in the other forms, and those in the region of the macula lutea are never star-like as in the nephritic variety. The general history of the case should confirm the diagnosis.

In **retinitis pigmentosa** not only the retina but often the choroid suffers in a peculiar manner, so that a well developed case can not well be mistaken for anything else. The disease is due to congenital predisposition. Physiological pigmentation around the optic disc and pathological pigmentation of the disc itself have been mentioned. In exceptional cases pigment may be deposited in the retina in the course of optic neuritis; but none of these constitute the disease in question.

Retinitis pigmentosa usually makes its beginning in the periphery of the fundus upon the nasal side and then extends gradually around, all the while advancing toward the posterior pole. It is characterized

by variously shaped black spots of pigment irregularly disposed or gathered into clusters. Some of these spots are round or oval, some have rough jagged edges and others, usually the larger ones, have long narrow processes radiating from them. Often the spots seem disposed to follow the course of the blood vessels which at times have black streaks or lines side by side with them. The last stages of the disease are characterized by atrophy of the retina and optic nerve, together with changes in the choroid. The latter consist in loss of epithelium in places, exposing the vessels and thus forming light patches which are usually fringed with dark pigment. If the choroidal structure becomes atrophied, the white sclerotic is seen shining through in whitish patches. The vitreous seldom becomes affected. The disease is generally binocular.

Syphilitic retinitis occurs in the course of constitutional syphilis. It so frequently closely resembles other forms of retinitis that the patient's history must aid largely in deciding its nature. Spots and opacities resembling those described under albuminuric retinitis form in the region of the yellow spot and optic disc, but they are of a duller hue and less persistent. They come and go, and require only a few days for new ones to appear and old ones to disappear.

The choroid and iris are apt to become implicated in this inflammation, and if atrophy of the choroid follows, changes similar to those described under retinitis pigmentosa take place.

Retinitis leucæmia is a very rare disease which sometimes accompanies a disease of the spleen and lymphatic glands. The fundus has a pale orange-red color if examined by diffuse daylight received through a hole in the closed window shutter. The papilla is pale and the retina about it clouded. The retinal vessels, notably the veins, are peculiarly pale. The cloudiness of the retina is striated. Small, irregular whitish spots are seen in the region of the yellow spot, and these are more numerous toward the periphery of the retina. Sometimes these spots are large and round and fringed with red. Effusions of blood are scattered over the fundus irregularly.

Hemorrhages into the retina are not often absent in any marked case of retinitis, but where the tendency to extravasation of blood is very great and the patient is one in whom some disturbance of the general circulation is known to exist, the term **retinitis apoplectica** is applicable. Hemorrhages in the retina seem governed by no rule as to extent, location or number. They may occur in the outer or in the inner layers. They may lie between the retina and

the choroid or may extend inward and burst through into the vitreous humor. Their location may be such as to partially or completely obscure the retinal vessels from view or they may lie directly behind these vessels, the latter being seen to pass directly over them. In this form of disease there is usually very little destructive change in the retina itself, owing to the slight nature of the infiltration, but the recurrence of the trouble is to be expected and it may lead to degeneration of the retina and optic nerve. The appearance of an effusion of blood into the retina, if seen early, is bright red. In all cases hemorrhages appear much darker than the surrounding fundus, and they retain their color a long time. If absorption takes place the spots gradually assume a brighter color, break up and disappear. If, as sometimes happens, they undergo fatty or pigmentary changes, black spots are the result, and these are more or less permanent.

Atrophy of the retina is a sequel to many inflammations of the inner parts of the eye. It may involve the whole or only a part of the retinal structure. Atrophy of the retina and atrophy of the optic nerve always go together. The central blood vessels are much attenuated and reduced in number or else quite lost. The increased thinness of the retina with its loss of reflection renders it very little obstruction to a distinct view of the choroid. Spots of exudation sometimes remain a long time in the retinal tissue, or pigment may become deposited along the course of some of the remaining bloodvessels.

Detachment of the retina means a separation of the retina from the choroid, and may begin at any point; it may remain small or extend in all directions. The lower half is most often the seat of a detachment. The appearances of a detached portion, if large, are those of a loose folding surface bulging more or less forward into the vitreous humor, and trembling with each movement of the eye. Its vessels are usually darker that those of the surrounding fundus and there is more or less cloudiness in the part. Sometimes the vessels can be traced in their tortuous course over the folds; but more often their continuity seems broken.

Small detachments are more difficult to see than large ones; their presence may be suspected if slight opacities are noticed at any point, together with a curving of the vessels passing over them.

Tumors of the retina demand a brief allusion. They are either **glioma** or **glio-sarcoma,** and present, if seen very early in their course, a small protrusion from the surface of the retina at some point, with some effusion about it, and perhaps some enlargement of the surrounding vessels.

As this is a disease of childhood, it is seldom seen until a later stage than above described, and the first thing usually noticed is a bright shining yellowish reflection from the fundus of the eye, seen by the unaided eye in a favorable light, or by the oblique illumination. With the ophthalmoscope the growth can be accurately examined so long as the media remain clear. It usually appears nodular and vascular upon its surface, and in color it is either orange, yellow or whitish. The reflection from such an eye is usually similar to that from a cat's eye seen in the darkened room. The further development of the tumor is that of increased growth and protrusion until it occupies the whole surface of the retina, and finally the whole eye.

Embolism of the central artery of the retina differs in ophthalmoscopic symptoms according to the position in which the embolus is lodged. If in the trunk of the main artery, before it divides, the arterial branches are reduced in size, and are nearly or quite bloodless. The optic disc is pale and transparent, and its vessels anæmic. The veins are either empty or irregularly filled, clots appearing to have formed at various points. The retina soon becomes cloudy, especially at its central portions, and in the region of the macula lutea, and the latter assumes the appearance already mentioned under serous retinitis, that is, it looks like a bright spot of effused blood owing to the surrounding retinal infiltration. If the obstruction continues in the artery, atrophy of the retina and disc will be the result. If it becomes gradually absorbed, the circulation may again be restored and the retinal opacity disappear. It is of very rare occurrence.

In **inflammation of the vitreous humor (hyalitis)** it is diffusely clouded with a grayish mist, which partially or completely obscures the fundus.

Besides diffuse opacity, there often exist opaque bodies varying much in shape and size. If the vitreous is in a fluid condition, these move about with the motions of the eye, and can readily be detected with the ophthalmoscope. Opacities from hemorrhage appear bright red, unless very extensive, when they may cause the whole fundus to appear dark. The location and amount of hemorrhage is subject to no rule. After absorption has begun, the color and form of the blood spots change to various irregular, fibrinous or filamentous shreds, either fixed or floating.

In a softened, fluid condition of the vitreous, a large number of small bodies are to be seen suspended in its substance; in fact, unless these bodies are present it can not be said positively that a fluid con-

dition of the humor exists. They are often in the form of fibrinous threads, interspersed with crystals of cholesterine.

An abundance of cholesterine crystals generally is present when the vitreous is in a fluid state, presenting a beautiful appearance. While the eye is at rest these crystals subside more or less completely toward the bottom of the chamber, but with every movement of the eye they become diffused through the fluid, and appear like particles of sparkling gold-dust. The term **sparkling synchisis** is applied to such a condition.

When a **foreign body** has entered the vitreous, if the media remain clear, the use of the ophthalmoscope will reveal its character and position. After some days have elapsed, the body is likely to become gradually covered with the products of inflammatory exudation, concealing it from view.

The treatment for diseases of the fundus demands experience. But in general it may be said that the treatment of optic neuritis, retinitis, or atrophy, varies with the cause, and is sometimes very protracted. Blue glasses and rest are always proper. Hyalitis requires the treatment of the primary affection.

The internal remedies must also be selected after a careful ascertainment of the cause of the trouble, due reference being had to special indications.

SECTION ELEVEN.

The eye is placed in such a position as to avoid many **accidents**. The overhanging brow shields it, and it rests in the orbit on tissues which are soft and yielding. But that which best protects it is the inherent sense of approaching danger, this sense so quickened that one eye warns the other, and causes the head to turn or bow instantaneously, the lids to close, and the globe to roll up and back.

It is also well-known that those who have lost an eye, not infrequently receive an injury to the remaining eye which might have been avoided by a person possessed of both eyes. This can best be accounted for by the supposition of one eye warning the other.

It is not a difficult proceeding to remove a bit of coal or other foreign substance from the eye, provided the patient is not nervous, unless the particle is imbedded in some one of the tissues. Nearly

all particles might be removed by the patient, if he would remember to draw the upper lid away from the globe and down over the under lid, with a few shaking motions. This maneuvre frees the foreign body from the contact, and the tears from the lachrymal gland suddenly acting on the stimulus given its branch of the fifth nerve, washes the body out or down into the inner canthus, where it may be found. But so few are able to accomplish this little maneuvre that turning back of the upper lid is generally demanded (explained in Section One).

Strong sulphuric or nitric **acids** are often splashed or thrown into the eyes by peculiar accidents, by design, etc., and require immediate attention. They act chemically on the tissues of the eye, and if in sufficiently large quantities disorganize the parts and produce sloughs more or less serious. There is great danger of symblepharon resulting. The cornea is also liable to suppurate if the epithelium is destroyed. Copious, deluging quantities of water should be used at once, as a little will do harm. The eyes should be syringed out with a weak alkaline solution, olive oil dropped between the lids, an oiled linen placed on the closed lids and a roller bandage and pad applied. The after-treatment is the same as that for quicklime.

Injuries to the eye from the contact of **quicklime**, **mortar, lime-plaster,** etc., are very common, and cause partial or complete destruction of the eye. The space of one or two minutes is sometimes sufficient for this, their effect being most disastrous on the cornea, producing acute keratitis, subacute keratitis, slough, panophthalmitis, with resultant leucoma or nebulous condition. The treatment should be to remove at once the foreign substance, being extremely particular that all is taken out, after which freely syringe with warm water. A spasm of the lids often makes this very difficult. If seen very early, dilute acetic acid (one drachm to one and a half ounces of water), or vinegar and water should at once be put into the eye. This will form acetate of lime, which is innocuous. At the time it is likely to be seen by the physician, however, this stage is past, and a little sweet oil may be dropped between the lids.

The great tendency is for the lids to adhere to the globe (**symblepharon**) or together (**anchyloblepharon**) owing to the raw surface made by the burn. These adhesions must be broken up by a probe dipped in sweet oil, and every attempt made to prevent their reforming. A mild, muco-purulent discharge may set in; this is to be treated as is that form of conjunctivitis. The resultant corneal opacity is usually indelible; if deep, no treatment will remove it.

When there is a slough, a lotion of an ounce of glycerine to six or seven ounces of distilled water will be found very soothing.

Burns and scalds affect the eye in a manner similar to other parts of the body, but that which would be a slight scald elsewhere becomes serious here. A scald whitens the surface, vesicates the epithelium and produces general redness of the lids and eye.

For treatment, use that which at first excludes the air best; then use soothing lotions until the sloughing stage is past, and when the sloughs have separated and healthy granulations spring up, stimulating applications must be used. At first it is best to put in a few drops of olive oil, cleanse the discharges from the eye with a glycerine lotion, and cover the eye with a little cotton wool held in place by a turn of a roller bandage. If the lids are severely burned, before applying the cotton wool put on lint soaked in carron-oil (about equal parts of linseed oil and lime water). If the burns are severe and the sloughs separating, it is better to leave off the bandage and apply soothing applications. Frequently bathe with a glycerine lotion; if very painful foment with decoctions; or, if there is no granulating wound of the external surface, apply a cloth repeatedly wetted with belladonna lotion. When the sloughs have separated from the eye or the mucous surfaces of the lids, or if conjunctivitis is present with a muco-purulent discharge, the injury should be treated as though it were this latter disease primarily.

The treatment of the resulting cicatrices from accidents and injuries, as well as the direct injury, often involves delicate parts so seriously as to require very skillful aid to save sight. The chances for a favorable operation afterward depend much on the care given at the time of injury.

For the treatment of injuries of an unknown or serious nature, it is impossible to outline a successful course of treatment; but it may be said that cold applications should be used in the beginning of an injury, a few drops of a weak atropine solution instilled at short intervals, and a protective bandage adjusted.

SECTION TWELVE.

By **refraction** is understood the faculty the eye possesses of focusing certain rays of light upon the retina; this is due to the shape of the globe and the refracting media, and is independent of the accommodative apparatus. By **accommodation** is understood the voluntary action whereby the eye becomes adjusted for vision of points nearer than is possible under refraction alone.

In viewing any point beyond about eighteen feet, the refraction alone is used, and the accommodation (or the eye sometimes) is said to be at rest; points nearer require the aid of the accommodation. Any object situated more than eighteen feet distant from the eye is said to be at an infinite distance; nearer, at a finite distance.

Emmetropia is a term for perfect refraction, that state in which parallel rays are brought to a focus upon the retina when the accommodation is at rest. **Ametropia** is a term for imperfect refraction, and embraces astigmatism, myopia, hypermetropia and presbyopia.

Astigmatism is that state of refraction, when the accommodation being at rest, rays of light emanating from a point are not reunited at a point. It is caused by asymmetry of the refracting surfaces, whence no image is correctly formed on the retina. It may be congenital or not, but generally is; when not, it is due to the results of inflammation of the cornea, defective union of the cornea after cataract operations, etc.

Its symptoms subjectively are generally that the eye sees more than one image, and these distorted in shape and position. Objectively, with the ophthalmoscope, distortion of the fundus is seen; and, with oblique illumination, irregular corneal reflections and changes of curvature are easily noted. The principal meridians are those of greatest and least curvature. Different focal lengths of the principal meridians, which are at right angles and generally vertical and horizontal, cause regular astigmatism; differences of refraction in the same meridian cause irregular astigmatism, which is incurable by glasses, though occasionally improved by stenopaic apparatus (metal discs pierced with small holes or slits). Regular astigmatism is called simple when one principal meridian is emmetropic and the other ametropic, as simple myopic astigmatism, or simple hypermetropic astigmatism: compound when both are hypermetropic or myopic, but the defect is

greater in one than the other, as compound myopic astigmatism, or compound hypermetropic astigmatism; mixed, when one principal meridian is hypermetropic, the other myopic, as mixed astigmatism with predominant myopia, or mixed astigmatism with predominant hypermetropia.

When the accommodation is at rest, and parallel rays of light entering the eye are focused in front of the retina, the condition is called **myopia,** divergent rays being focused upon the retina. The cause is that the optic axis is too long, a too high refractive power. It is often hereditary. Anything that favors congestion of the globe, as straining the eyes at fine work, reading by too dim a light, or reading in a recumbent posture; stooping over at the desk, etc., may cause it.

In myopia the far point lies nearer the eye than in emmetropia. A myopic eye is often considered as necessarily of strong sight, and hence not regarded as unsound. This is erroneous. While a stationary myopia of low degree may not necessarily be a serious matter, it must always be regarded as liable at any time to become progressive; a progressive myopia of high or low degree is a serious matter. One of high degree, accompanied by staphyloma, is dangerous to vision in advanced life, always affecting the sight more or less; one of high degree, accompanied by posterior staphyloma and attendant atrophy of the optic nerve, not infrequently ends in blindness. The latter grades are nearly always attended by asthenopia, much irritation and amblyopia.

Myopia is often confounded with spasm of the ciliary muscle, and the latter diagnosticated as myopia. Spasm of the ciliary muscle is curable by medicine, myopia is seldom, if ever. The two may be associated, and the spasm being overlooked, an improvement of the myopia is supposed to be accomplished by medicines, whereas it is the spasm that is relieved.

Myopia may be diagnosticated by the ophthalmoscope, in which case the details of the fundus can be seen by the direct method a short distance away; carrying the ophthalmoscope to one side, the fundus is seen to move in the opposite direction. On a nearer approach, a concave glass will be required to get a clear, erect image. By the indirect method the details of the fundus seem smaller than in an emmetropic eye.

The distance of the far point determines the degree of the myopia. A patient who does not clearly see beyond thirty-two inches is said to have myopia equal to $\frac{1}{32}$; beyond twelve inches, myopia equal to $\frac{1}{12}$, etc.

A stationary myopia through youth has a compensation in that the necessity for lenses for old sight does not exist until the error due to myopia is overcome by the senile change. Sometimes this never happens, hence lenses are not required. Much in the way of medical relief can now be accomplished, and internal remedies should be tried before any lenses are ordered.

When the accommodation is at rest, and parallel rays of light are focused behind the retina, the condition is called **hypermetropia.** Convergent rays are focused upon the retina. The cause is that the optic axis is too short; when caused by senile changes in the eye, aphakia or absence of the lens, there is low refractive power. It may be hereditary.

In hypermetropia the eye cannot see distant objects without using a certain amount of the accommodation, or what optically amounts to the same thing, a convex lens; in emmetropia no accommodation is used for distant objects, the refraction alone sufficing. This abnormal use of the accommodation overtasks the eye, causing spasm of the ciliary muscle, strabismus, etc. Latent hypermetropia is that which is habitually concealed, and only revealed by the use of a strong mydriatic; manifest hypermetropia is that which is present without the use of a mydriatic. The latter is represented by the strongest convex lens through which the patient sees distant objects most acutely; the total hypermetropia by the strongest convex lens through which the patient sees distant objects most acutely after a strong mydriatic has acted; the difference between the two represents the latent.

Hypermetropia is divided into three kinds: facultative, that in which the patient sees near and far objects clearly with or without convex lenses; relative, in which the patient sees near and far objects clearly, but only by converging the visual lines to points nearer than the objects, giving the eyes a periodic squint; absolute, in which neither near nor far objects can be seen clearly without convex lenses.

In examining patients, it should be borne in mind that the two eyes will often be found to differ greatly, either in grade or kind of defect. One eye may be myopic and the other hypermetropic, or one eye emmetropic and the other hypermetropic or myopic, forming anisometropic myopia; or similarly hypermetropic, causing anisometropic hypermetropia, etc.

Hypermetropia may be diagnosticated by the ophthalmoscope, with which the details of the fundus may be seen some distance away; carrying the ophthalmoscope to one side, the image of the fundus moves in the same direction. On a nearer approach, a convex glass will be

required to get a clear, erect image. By the indirect method, the details of the fundus look larger than in an emmetropic eye.

Asthenopia is a very common trouble, and is caused by a lack of strength. Frequently it is due to some error in the refraction or the accommodation. It is also due to such a multiplicity of other causes, however, principal among which are muscular debility from any cause, as diphtheria, typhoid or other fevers, uterine diseases and other constitutional troubles, that a thorough knowledge of general medicine and surgery is essential to finding and removing the cause. Many such cases, as well as the severer diseases of the eye generally, are the results of fundamental changes in the structure of the body, or deterioration of important organs, and are not merely functional disorders, as is commonly supposed.

When once a case has settled into a chronic one, it is often difficult to cure, hence the importance of an early recognition and suitable treatment of this trouble.

Aphoria is a term used to indicate troubles arising from muscular errors due to weakness or insufficiency of the ocular muscles, whence the visual axes of the two eyes are not harmonious or in the same plane. Hyperphoria implies a dissociated upward movement of one visual axis from the horizontal plane; hypophoria a similar one downward; exophoria one outward from the vertical plane; and esophoria a similar one inward. The unfolding of the subjects of **ametropia, asthenopia** and **aphoria,** affords a solution of the causes of headache, neuralgia and similar troubles heretofore unsolved. While it is impossible to briefly elucidate these complicated processes, in a general way the present knowledge may be epitomized as follows: Refractive are more common causes than muscular errors in the production of headache, though the latter are more certain to produce it; and of refractive errors, astigmatism and hypermetropia are relatively the most frequent causes of this complaint. Hypermetropia most frequently is the cause of strabismus and perhaps blepharitis. Insufficiency of the inferior and superior recti muscles, either alone or complicated with the lateral muscles, is a common muscular error. Vertical muscular error is more apt than any other muscular error to produce headache; combined with astigmatism, it is almost certain to do so. Sometimes these errors produce chorea, and possibly epilepsy, as both may be alleviated, when such errors are present, by lenses. The revelations of aphoria in connection with ametropia and asthenopia, and their mastery by lenses, local or internal medication, and the delicate operations so successfully performed, are the later triumphs of modern surgery.

SECTION THIRTEEN.

For many years after their discovery, no special advancement was made, and the use of **lenses** remained confined to supplying the deficiences of the eye consequent on age. During the past half century, however, and especially during the last quarter, the subject has been carefully studied by men eminent in the known sciences. That use which was based on a simple accidental discovery, has been supplanted by one controlled by unvarying laws solved by the higher mathematics. Opinions based on the knowledge of past years should be discarded. No age is now necessarily implied by their use. They may be worn by any one at some period of life, for one or more of the many affections to which they give relief.

These researches have also shown that a large class of troubles, hitherto numbered among the incurable, are readily amenable to treatment by lenses alone; and diseases formerly allowed to go on for the want of a remedy, are now by their use promptly arrested. Many who are totally unconscious that their sight is defective, are relieved of troubles and made to see in a manner they never deemed possible. Others who have been obliged to abandon occupations on account of supposed failing sight, can now return to them.

It was but comparatively recently that the inheritance of an optical defect was one of the most unfortunate hereditary calamities. This thorough study of the laws governing the use of lenses, however, has wrought one of the pleasantest of changes. By it, members of the same family may be placed upon widely different planes of life; for occupations closed to the older members by reason of such inheritance, are open to the younger. Inability to use the eyes for near work from inherited refractive defects, has become almost a thing of the past.

It is as useless to expect to do away with lenses for eyes requiring them as it is foolish to attempt it. The value of lenses to every one at some period of life, and their absolute necessity to many at all times, should do away with all prejudices against their use, and lead to its study. Such study will not only remove erroneous notions, but by awakening interest in newly discovered optical laws, stop the impositions of prowling pretenders.

Nearly all persons are familiar with the fact that lenses have been worn as aids to sight; but many have confused notions regarding

their functions. Indeed, it will not be far out of the way to say that a large proportion of the laity know almost nothing of their uses beyond that they help the aged and weak-sighted. So strong have these notions become implanted, that it is not infrequent to find employers declining to engage an applicant wearing glasses; or those needing them going without them, because of the idea that they impart a tinge of age or indicate a lack of capacity. In the hands of a skillful person there is no remedy at this day which will in their varying combinations so frequently assist the sight, as suitable lenses.

Causes for the use of lenses may also be found in headaches, neuralgia of the eye and general system, cross-eye, spinal irritation, nervous prostration, choreic spasms, sleeplessness, depression of spirits, irritability of temper, inability to concentrate the attention and apply the mind, and other oculo-nerval reflexes, produced or sustained by a faulty shape of the eye and weakness of the ocular muscles.

Focal glasses. To overcome myopia, concave spherical lenses are used, because they render parallel rays of light sufficiently divergent to impinge sharply on the retina; to overcome hypermetropia, convex spherical lenses are used, because they produce the opposite effect optically; presbyopia is corrected by convex spherical lenses, because they supply the deficiencies of accommodation and refraction; and astigmatism is corrected by concave or convex cylindrical glasses, with or without a combination with the other kinds as may be indicated, by restoring the symmetry of the different meridians of the refracting surfaces.

Non-focal glass may be recognized by holding it up to the light and noting if a perpendicular line moves with the glass when it is slowly moved from right to left, or the reverse. If it does, or moves in an opposite direction, or if images are distorted, the glass does not belong to this class. The common, cheap coquilles, and by these are meant the common curved blue glasses so generally worn (but not what are known as goggles, which never should be habitually worn in eye disease, and not at all unless by order of a physician), are made of pressed or molded glass, and it is quite rare to find such without focus, nearly all presenting a negative meniscus. This defect can be obviated, however, by a pair which have been ground, not molded.

The colors proper for these glasses, and their correct adaptation should be considered, for it is extremely rare to find anyone who has any suspicion that such glasses are in any manner injurious to the eye or sight. It is not at all uncommon, however, to find cases where the deeper portions of the eye are kept in a state of chronic irritation from

their use, by which other parts of the eye from reflex action are sympathetically disturbed.

The ordinary double-convex or double-concave lenses are alike on both sides, the convex lenses being convex on both sides, the concave lenses concave on both sides. **Periscopic lenses** are concave on one side and convex on the other, the concavo-convex having a shorter radius of the convex surface; the convexo-concave a longer. Could it be done, all lenses should be put into the eye, so that they would become an integral part of the globe. Such not being possible, they are placed directly in front of the eye. Unfortunately they cannot move with the eye, and hence when the axis of vision, owing to the turning of the eyes, is no longer directly in front through the centers, as is often the case, they prevent free vision in a greater or less degree, according as they are stronger or weaker in power. To overcome this trouble, one must turn the head rather than the eye. With periscopic lenses, less of this trouble is noticed, for there is a freer range of the eye behind the glass, thus permitting a clearer view of objects lying in an oblique field of vision.

The question of **material for the composition of lenses** must be decided by the use to which the glasses are to be put. All lenses are made from two materials, glass and rock crystal, the latter being the material generally known as pebble, the distinctive adjective usually being taken from some remote district of high-sounding name.

The great object is to select that material which disperses light the least in proportion to its refractive power. The preference for pebbles is often claimed on the ground that the polish on their surfaces is higher, and hence they do not scratch as easily; and that the material is perfectly white and transmits a pure light, while even the best glass has a greenish tint. This remark about the non-transparency of glass was true, but a transparent glass is now readily and cheaply available to all opticians, and transmits a pure, clear light. In this preference the greater object should overcome the lesser one; hence for glasses of high power, and especially concave ones, crown glass should be selected; for weak ones, and especially weak convex ones, any prejudice for pebbles may be safely indulged. By the use of the **pebble-tester,** however, supposed pebbles may be found to consist of glass, and ideas of the relative value of the different kinds changed.

This test consists of two plates of tourmaline, between which the lens is placed, and then held up to the window. If the lens is pebble, the light is polarized, and colored rings appear; if it is glass no effect

is produced. Pebble is also a better conductor of heat than glass, hence a lens made from it will seem colder to the tip of the tongue than one made from glass. In order that the pebble lens may be of its greatest value, it is essential that its axis be at an exact right angle to the axis of the double refraction, this double refraction being a peculiarity of pebble in one direction. But if care is taken in this respect, not so many lenses can be cut out of one piece of crystal, hence it is sometimes disregarded, and in consequence the image seen through them is more or less blurred and fuzzy on its edge. Resource being again had to the pebble-tester, the defect can be easily detected; for if the lens is rightly cut the rings of colored light will be circular; if not they will be more or less irregular or eliptical in shape, or as opticians usually say, prismatic colors will be abundant.

Unprincipled dealers often seek reputation by pretending to have superior glasses under the names of "clearers," "restorers," etc. Too strong glasses for a time seem to make the sight better also, but they quickly fail to be valuable and cause the eyes to ache.

The proper kind of glass having been determined upon, it is important that the **correct frame** is selected. It is not enough that the lens is correct, its erroneous adaptation to the eye may defeat much gained by its use. The distance between the eyes should be considered, in connection with the shape and style of the nose, and an adaptation made of some one of the kinds. The material for the construction of the frames, is usually a matter of taste.

When glasses are to be worn for seeing at a distance, the connecting bridge should be longer than when they are to be worn for near vision, because the visual lines are practically parallel; if for both near and far, a medium may be sought. In addition, the lenses of the first should be set high, in order that they may correspond to the plane of the pupils. To see near objects, however, the lenses should be set low, and the lower edge of the lenses inclined backward.

Sometimes when a person has old sight supervening on over-sight, or has absolute over-sight, it is convenient to have two pairs of lenses in one frame, the lower half of the lens stronger than the upper; or if short-sighted, with diminished range of accommodation, the upper half concave and the lower half convex. Such glasses are known as **Franklin glasses,** or glasses of double focus, and may be mounted in the same frame. If suitably adjusted, they are very convenient, and often greatly liked by the wearer, but in the hands of some require such careful adjustment, that they weary and annoy.

The natural stimulant to the special nervous elements of the retina is sunlight which is reflected by objects in their different colors. If **blue glasses** are ordered, certain colors are changed or shut out. This is often desirable for very nervous persons, or when traveling on lakes, where the reflection from the water is strong, or in morbid states of the retina. Formerly **green glasses** were almost universally used, but they have been generally displaced by blue; for while reflected green light is agreeable, transmitted often is not. But if it is not desirable to so shut out or change certain colors it is necessary to order the lenses in a **neutral tint** known as London smoke, for these glasses exclude each color of the solar spectrum in equal proportions, and so simply soften the light.

Up to about the year 1860, when the present system of **measurement of lenses** in inches was practically introduced, there was no generally accepted way of numbering lenses. A manufacturer might make twenty powers of lenses and number them from 1 to 20; another might make only twelve powers of lenses embracing the same range, and number them from 1 to 20, and so on, so that the number 10 of one manufacturer might be the number 7 of another, and the number 13 of another, etc. To overcome this, it gradually came to be understood that the number of the glasses indicated their focal length in inches. But the refracting power of a lens also depends on the index of refraction of the glass, varying with the kind of which it is composed. The Parisian inch is the equivalent of 27.07 millimetres, the English of 25.30, the Austrian of 26.34, and the Prussian of 26.15, while the index of refraction of the glass of which lenses are constructed varies all the way from 1.526 to 1.534. Hence there were sources of error in all calculations, for even though the country was known where the lenses were made, and presumably they were made on the standard of that country, the **refracting power** could never be told unless the index of refraction of the glass was known. In order to simplify the latter, a common index of refraction of 1.5 was accepted, but even with that wrong basis, only part of the trouble was removed, so that as a compromise it became generally accepted that the number of a lens indicated both the focal distance and the refracting power. Thus a lens numbered 9 had a focal distance of nine inches, and a refracting power of $\frac{1}{9}$. But it was known all the time that it had not, and it in no wise made an intelligent person feel that a practical matter was solved by feigning to believe what was known to be wrong. A sensible system of notation would indicate either the power of refraction or the focal distance of a lens. This old system

did neither, and by making the unit too strong necessitated the constant use of fractions in all calculations. Practically there is much more to do with the refracting power of a lens than with its focal distance. The refracting power is always the inverse of the focal distance. The numbers of the old system give the focal distance of the lens in inches, the unit being a lens of one inch with a refracting power of $\frac{1}{1}$. There is seldom need of this lens in practice, and it is not put in trial cases.

To obviate these difficulties many oculists offered plans and introduced them at different conventions. As a result, at the International Congress of Ophthalmology in 1867, a new **system of numbering** all lenses according to the refracting power was proposed. After a short delay, that which is known as the new or the **metrical system** was adopted. A lens of one metre focal distance, instead of one inch as in the old system, was selected as the unit, called a dioptry, and numbered 1. This dioptry, a metre, is the equivalent of 100 centimetres, 1,000 millimetres, or 39.33 English inches. Thus by following the cardinal numbers, there is a series of lenses with an interval of one dioptry, as No. 2 is twice as strong as No. 1; No. 20 twenty times as strong as No. 1. Unfortunately there is need of lenses weaker than one dioptry, and at intervals between dioptries, so that this system does not after all remove the need of fractions, and there are lenses of .25 and .50 dioptry, 1.75 and 2.50 dioptries, etc.

To adjust lenses to refractive anomalies, **trial cases** are used, and are indispensable for one who is not skilled in that branch of ophthalmoscopic optometry which treats of measuring the refraction of the eye with the ophthalmoscope. Even then it is usual to make use of them, though advantage is derived from being able to confirm their estimate of the refraction by the latter method. These trial-cases, when complete, are composed of glasses of the various kinds known, with which the applicant for glasses tries or tests the eyes under the guidance of the physician, the examination being subjective. When the correct lenses are thus found by trial, duplicates of such lenses are ordered for the patient to wear, they being ground and set in a suitable frame. It is essential to test the eyes separately, for it is not at all uncommon to find them differing in their refractive power. Lenses being designated by the metric system, as well as the old inches, in ordering lenses, if the new system is used, the numbers should be designated by a "D" (Dioptry) following each number thus: .5D., 1D., etc.

At first glance it will seem that there is no objection to giving a glass suitable for the correct measurement of the refractive power of each eye. But the eyes do not see, they act simply as an optical box; sight lies in the brain. Convex lenses enlarge the image of an object, and concave ones diminish it. If there is placed before one eye an enlarged image, as would be brought about by the use of a convex glass essential in the case of a hypermetropic eye, and a diminished image before the other eye, as would be produced by a concave lens essential in the case of a companion myopic eye, the effect would be the same as in endeavoring to see two overlapping objects with one eye. Neither would be seen well. There are exceptions to this rule, as to all others, but the general principle holds good. The practical difference found to exist, if it does not exceed one-forty-eighth or one-sixtieth of an inch may be neutralized in both eyes by correctly fitting glasses; when it exceeds this, it will be found the better rule to fit the eye with the better sight, and give a corresponding glass for the other eye. It by no means is always true that the eye with the better refraction is the better one for vision, for it may be amblyopic, and hence not be as useful as the other which has the poorer refractive power.

If, however, such eyes are to be used for any purpose requiring accuracy of fixation, as in rifle-shooting, or the determination of lines, as in surveying, etc., it will generally be found that the right eye must be the one to be fitted; for on trial it will be found that the preference to the right eye is usually given in such matters.

SECTION FOURTEEN.

In order **to fit lenses** for refractive troubles, it is essential to have a set of **test-types** in addition to the trial case. For a number of years much confusion resulted from there being no uniform way of testing vision. To overcome this, it was agreed by common consent to make use of a set of letters drawn upon a given scale. Snellen and Jaeger both devised such sets, and as each has merits peculiar to itself, each is used; the former being considered better for the determination of the acuity of vision, and the latter for the ease of reading. Snellen's letters are square and their size increases in a definite ratio, so that each kind is seen at an angle of five minutes,

No. 3 being seen at a distance of three feet, No. 2 at a distance of two feet, and so on. As a rule, these letters can not be seen distinctly beyond these distances.

The standard of measurement of lenses having been changed from inches into dioptries, so as to have a uniform standard, the same unit of measurement was taken for the **measurement of the distance** of the test-types. Thus a person who has normal sight reads the test-types at the distances corresponding to the numbers marked thereon. If in feet, No. 200 is read at 200 feet, No. 20 at 20 feet, and so on. But if the new system is used, No. 60 is read at 60 dioptries, No. 6 at 6 dioptries, and so on.

An eye suffering from diminished acuity of vision, in order to gain large retinal images, will demand a larger retinal angle than five minutes to see the letters, and hence No. 1 can not be seen at one foot, but for example, only at a distance of six inches, and so on.

If, then, the card of Snellen's types is placed at a distance of twenty feet, or, according to the new nomenclature, at a distance of six dioptries, and the observer see No. 20 of the first, or 6 of the second, plainly, the vision is perfect, 20-20ths or 6-6ths. If, however, that which should be seen at 70 feet, can only be seen, the vision is 20-70ths of what it would be were it normal. In practice the fractions should never be reduced, but the denominator allowed to remain the distance at which the test-types should be seen, and the numerator the distance at which they are placed. For the eye in a state of rest depends on the refraction alone, but when viewing any object nearer than about eighteen feet, the accommodation is used, so that practically 2-7ths is not 20-70ths. In the former case the expression would mean that the types used should be seen at 7 feet, and were only seen at 2 feet, the accommodation being used, or in a condition where it might be used if not diseased. In the latter case the expression would mean that the types should be seen at 70 feet, but were only seen at 20 feet, the refraction alone being used, as the distance at which the types were placed was such as to preclude the use of the accommodation, for it must be at rest at a distance of 20 feet. Moreover, there is some advantage in using the scale of tens when fractions are involved, as will be seen when the adjustment of lenses is attempted.

Jaeger's types are not square, but similar to those in ordinary use. Already familiar in ordinary reading, they are the more readily seen and recognized.

Short-sighted lenses should be worn near the eyes; over-sighted ones not necessarily so. Astigmatic glasses should be carefully kept

in the exact position designated, otherwise they impede rather than benefit vision.

Inasmuch as no one sees with the eye, but with the brain, the eye may be perfectly fitted as to its refraction, the image perfectly formed, and yet there be no vision, the sensorium taking no cognizance of the image present. This will afford a solution to many otherwise unsolved and seemingly incomprehensible, optical problems.

To make a **practical application of lenses,** a person whose vision is suspected to be imperfect should be seated at twenty feet from No. 20. If every letter seems black and the outlines of the letters clearly defined, there is apparently normal vision for distance, but the eye may still be hypermetropic. In order to determine this, place in front of the eye a plus 72 inches lens, and let it look at No. 20. If the letters are slightly dimmed, or less distinctly seen, the eyes are normal for distant sight. If, however, with such a lens the sight continues as good as before, try a plus 36 inches lens; if it still sees as well, try a stronger, and so on until the letters are getting dimmed. The manifest hypermetropia is now overcome, but most likely there is some latent. The strongest lens with which sight is as good as it is without it, represents the manifest hypermetropia. With this trouble, however, as with myopia, there is danger of confounding spasm of the ciliary muscle. A more complete description of the latter affection will be given; it requires care to detect it.

The total hypermetropia is determined by paralyzing the accommodation with atropine and then selecting a lens of sufficient strength to render distant objects clearly visible. This lens represents the total hypermetropia.

It is often well, though not necessary always, to completely paralyze the accommodation in cases which require examination. This is effectually done by instilling into each eye three times a day, for one or two days, a drop of a solution containing four grains of pure neutral atropia sulphate to an ounce of distilled water.

Generally it will be found in practice, that the strength of the lenses to be prescribed for individual cases should not be sufficient to correct the total hypermetropia. Correction of the manifest hypermetropia with a small amount of the latent, is often sufficient at first, and relieves any asthenopia due to the affection. Lenses sufficient to do this may be worn until an additional amount of the latent hypermetropia becomes manifest, and then be replaced by stronger ones. As a rule, young persons who see as well, or better, with their mother's or grandmother's glasses, are hypermetropic.

The correction, at first, of the total hypermetropia, is often found practically to be attended with more or less discomfort to the patient; for it is seldom that a patient can at once wholly dispose of the habit of accommodating. The involuntary accommodation added to glasses of full strength, renders the refraction in effect myopic. One must, therefore, by easy stages, be educated to the use of stronger and stronger glasses, until accustomed to the use of those which are equal to the total hypermetropia.

For children affected only in a slight degree, and in whom the accommodative apparatus is in full vigor, glasses which overcome the hypermetropia for distance are all that may be required for many years. For old people, in whom the power of accommodation is nearly lost, glasses equal to the total hypermetropia may generally be prescribed at once.

In regard to the **use of lenses for hypermetropia**, it is best that it should be constant. If the glasses are laid aside at intervals, a return of the old symptoms is apt to follow, and no progress will have been made in overcoming the disorder of the accommodation. However, in young persons who experience no inconvenience except while engaged in near and fine work, the lenses may meet all requirements if worn only while engaged in such work.

In advanced life, after presbyopia has set in, hypermetropes often require two pairs of glasses, the strong for near, and the weaker for distant vision. These may be combined in one frame if desired.

When lenses of a high power are required, as in near vision in hypermetropia of high degree, the **centering** and **adjusting the lenses** properly is a very important matter. By centering is meant that the lenses should be so adjusted as to allow the visual lines to pass through their axes, for when light passes too near the edge of either a convex or a concave lens, the lens acts as a prism.

So close is the association between the functions of accommodation and convergence, that a slight disturbance in their equilibrium, as by the action of improperly centered lenses, may be attended with very painful nervous symptoms. Notwithstanding the lenses may be properly centered, they cannot change with the movements of the eye. If the visual lines always remained in the same relation to the centers of the lenses, or, in other words, if the eyes always maintained the same degree of convergence, and only moved in exact conjunction with the movements of the head, lenses could be so centered and adjusted as to be always a fixed and reliable factor in the visual apparatus. But not only does the angle which the visual lines make with each other change,

according as near or distant objects are observed, but also when the eyes are turned outward, upward or downward, the visual lines pass near and even beyond the edges of the glasses, thus causing confusion and indistinctness of vision.

The distance and size of objects is estimated in part by the amount of effort required in the accommodation and the convergence of the eyes while viewing such objects. The association between the functions of accommodation and convergence is constant. Convex glasses placed in front of hypermetropic eyes cause the accommodation to relax; a certain degree of convergence has always been associated with some given degree of accommodation, hence the patient at once associates with the relaxed state ef accommodation, a certain increase in the size and distance of objects. Objects often seem to recede, and in walking, the floor or pavement seems farther away than natural, and the patient feels as though constantly stepping to a lower level.

The eyes that are unused to the wearing of convex glasses must often become accustomed to them in more respects than one, before the effects of the new conditions, consequent upon their use, will seem real and agreeable.

It has already been mentioned that late in life all eyes become presbyopic, and usually to that degree that they cannot exert the accommodation necessary for reading and fine work; therefore stronger glasses are required for such purposes, while those glasses to which the patient has already become accustomed remain good for distance. A patient with hypermetropia of two dioptries, and wearing lenses of sufficient strength to correct it, would, in the ordinary course of events, at the age of forty-five, have presbyopia amounting to about one dioptry. The addition of one dioptry to the strength of the lenses, making the lenses three instead of two dioptries, would therefore be required for near vision.

One of the most common **results of hypermetropia** is convergent squint, or cross-eye. At about the age of five or six years, children are usually put to school and there required to read and write, and to otherwise use their eyes for fixing small objects more or less distinctly and continuously. This is the time when convergent squint most often makes its appearance, and the timely use of convex lenses will, in many cases, prevent this condition.

To adjust lenses for myopia, the patient should be seated as directed for hypermetropia, that is, at twenty feet from No. 20. If now the letters are not distinctly seen according to their numbers, nor do convex glasses of any power improve the vision, myopia may

be suspected to be present. Place in front of the eye a minus 36 inches lens; if this improves the vision and brings to view a smaller set of letters than could before be seen, change to a stronger concave lens, and so on until No. 20 is read. The weakest lens with which No. 20 can be easily read, will be the measure of the myopia, if no spasm of the ciliary muscle is present. But if no glass is found which permits of this, the eye may be amblyopic or astigmatic and require other aid. But owing to complications which may exist and render vision otherwise defective, it must not be expected that all cases of myopia can be brought to a normal standard of vision for all distances.

In the **choice of lenses,** many complications are met in individual cases. In high degrees, weaker glasses for near and stronger for far vision are usually given. In moderate cases, those of three dioptries or less, one pair of lenses will often subserve both purposes, and may be constantly worn.

For far vision in any case, the glasses chosen should be the weakest which render distant objects most distinctly visible. These same glasses would answer for near vision, as for reading, etc., were it not for the diminished power of accommodation, so common in myopic eyes. This is the result of disuse of the accommodative apparatus, and consequent weakness. Therefore when either one or two pairs of glasses are required, those which fully correct the myopia, and no stronger ones, should be given for distant vision.

The **strength of the glasses** to be used for near vision in any given case, must depend much upon the state of the patient's accommodation. If the accommodation is good and the myopia does not exceed five or six dioptries, a patient can sometimes, without inconvenience, wear lenses which nearly but do not quite correct the defect. But the stronger the lenses used the smaller will be the retinal images, and the greater the strain upon the accommodation.

The treatment of myopia, by the use of concave lenses, depends upon the principle that carrying objects farther from the eye does away with an excessive amount of convergence which overtasks the eyes, and increases and perpetuates the trouble. This fact should be impressed upon the minds of patients, or the most carefully adapted glasses will often fail to accomplish their purpose; for habits once formed are hard to overcome, and the habit of bringing the work very near the eye, unless due care is exercised by the patient, will often be persisted in after the glasses are given. This matter needs especial attention in the case of children; for in them the disease is especially apt to increase.

The object usually in using lenses for near vision, is to remove the far point to a convenient distance for reading and fine work, thus preventing straining of the eyes by unnecessary convergence.

Suppose a patient has a myopia of five dioptries, the far point is at about eight inches. It is desired to remove it to a convenient distance for reading. A myopia of three dioptries has the far point at about thirteen inches; a myopia of two and one-half dioptries has the far point at about sixteen inches, and either distance is convenient for reading. Lenses are therefore given which reduce the myopia to either 3 or 2.5 dioptries. A lens of 2 dioptries will accomplish the first, a lens of 2.5 dioptries will accomplish the second.

In slight cases of myopia, 1.5 dioptries or less, the only inconvenience experienced is not seeing distant objects distinctly; so if the patient does not unconsciously, or through ignorance of the effect, bring work too near the eyes, very little inconvenience will be experienced, and no glasses desired. Children need especial care in regard to this matter of holding the work too near, for the defect is not only aggravated by it, but may be created in perfectly normal eyes. Until the vision has been properly tested, a child should never be corrected for holding work too near.

The remarks concerning the **centering of the lenses** under hypermetropia, are quite as applicable to myopia. The visual lines should pass through the axes of the lenses, and, for this reason, the lenses for near vision, owing to the convergence of the visual lines, should have their axes nearer together than those used for far vision.

Spasm of the ciliary muscle occurs in hypermetropia or myopia. When due to hypermetropia it occurs in young people most frequently. While their eyes appear myopic and concave glasses improve vision, the use of the ophthalmoscope, or paralysis of the accommodation with atropine, reveals hypermetropia. The state of the refraction in such eyes is also variable, causing one power of lenses to fit at one time and another power at another. But the strength of the lenses which render vision normal at any time, is much less than the apparent degree of the myopia would seem to indicate. Such cases require medical treatment.

Cases of myopia which increase rapidly, should excite suspicion of spasm of the ciliary muscle, especially if they are accompanied by marked symptoms of asthenopia on using the eyes for reading, or for near work.

One of the various complications, which often accompanies and is dependent upon myopia, is **insufficiency of the internal recti**

muscles, whose function it is to draw the eye inward. This affection is most common in myopia of high degree, though it may be present in almost any grade. The cause is to be found in the overwork of the internal recti muscles while producing the excessive convergence of the visual lines necessary for near vision. The muscles become fatigued after continued exercise in reading, and one eye finally rolls outward.

The subjective symptoms of which the patient complains, are heat, pain, fullness and pressure in and about the eyes, with dimness and confusion of vision. These disappear after resting the eyes awhile, only to be renewed as work is resumed.

On examination of the eyes in a case of suspected insufficiency, they appear normal. But hold a pencil, or some similar object, vertically in front of the patient's eyes, and while they continue to look steadily at the object, gradually carry it toward the eyes. When the object is within five or six inches of the patient, one eye will become unsteady and roll outward. This outward deviation may be gradual or sudden.

But a better test is to place a prism of ten degrees, base down, before the right eye, and have the patient look at a dot on a vertical line. Two dots will be seen, one above the other. If both are on the line, there is no insufficiency present; but if the upper dot is to the right, the internal recti are deficient; if to the left, the external recti have been overcome. In the normal, or emmetropic eye, the prism simply has the effect to cause the images to appear double, one image being directly above but not to one side of the other. The strength of the prism required to fuse the two images, is the measure of the insufficiency. When they are to be worn, these prisms should be placed in frames, bases inward, and the proper convex lenses ground into the prisms.

The **action of prisms** is to deflect rays of light inward toward their bases; therefore, rays from near points, on passing through them, enter the eyes as though they came from greater distances. This disposes of the excessive convergence of the optic axis. The proper concave lenses relieve the accommodation, the proper prisms, bases inward, relieve the convergence.

With the best possible adaptation of glasses, the vision of some myopic eyes is but little improved, especially for distant objects. This fact is susceptible of explanation in various ways; but perhaps the most constant and potent cause is to be found in the fact that the perceptive elements of the retina are spread over a larger space in the myopic than in the emmetropic eye. Concave glasses, while they

bring parallel rays to a focus at their proper place upon the retina, and thus make the image distinct, also diminish the size of the images so much that sometimes little advantage is gained.

Many persons affected with myopia, refuse to wear glasses in the hope that with the advance of age, they may have no need of them. Such a course is not to be commended, for not only is the affection more apt to increase thereby, but these persons constantly undergo much unnecessary discomfort, and not infrequently produce a systemic disturbance.

When two pairs of glasses are given to one person, explicit directions should be given regarding their use, and the patient should be especially warned against attempting to use the stronger glasses for near vision. It is a question whether considerable harm is not caused by the thoughtless observation of near objects while the stronger glasses are in use. The stronger glasses are simply intended to contribute to the comfort of persons wearing them, permitting them to see at a distance; the weaker glasses are intended to prevent the progress of the affection, and should not be laid aside while engaged in reading or near work.

Lenses of any power, however, may often be more serviceable of a blue, green, or neutral tint, as may be necessary or desirable in different forms of trouble. It is usually better not to order them ground in tinted glass, for the glass being of varied thickness, the shade is unequally distributed over the field of vision, especially in the stronger glasses, but preferable to attach to one of the surfaces a colored plain glass by means of Canada balsam, which is transparent.

The methods of testing and **measuring astigmatism** are very numerous, and as in the other forms of ametropia, may be either subjective or objective. All subjective tests depend upon the fact that if the astigmatic eye looks at a number of lines of uniform width, drawn in different directions, some will appear clear, and others more or less indistinct. The lines used for this purpose should be clear, sharply defined, and not too narrow. Diagrams for this purpose may be obtained at any medical bookseller's. The normal eye is slightly astigmatic, but if the difference is less than one-fortieth of an inch, it causes no appreciable disturbance of vision.

All lenses for the correction of ordinary errors of refraction are segments of spheres; those for astigmatism often combine two kinds, the spherical and the cylindrical, though sometimes the latter is sufficient. A cylindrical lens is the longitudinal section of a cylinder, and may be either convex or concave according to the portion of the

cylinder it is taken from. It may also be either plano-convex or plano-concave, bi-convex or bi-concave, a positive or negative meniscus. When a cylindrical lens is combined with a spherical lens, the resulting lens is termed sphero-cylindrical. This lens is made with one side ground spherical, and the other cylindrical.

Rays of light falling on the plane of the meridian passing through the axis of a cylindrical lens, do not change their direction, there being no refraction in this meridian. In all other meridians, however, the light is refracted, but in degrees, increasing as the meridian is more nearly perpendicular to the axis of the cylinder. In the perpendicular meridian, the highest degree of refraction is obtained.

Similar differences of refractive power taking place in the astigmatic eye between the least and the greatest deviating, or the principal, meridians, it follows mechanically that if a glass of the cylindrical form compensating for the deviation in any meridian, is placed in front of such meridian, the eye will be in a correct state of refraction.

Simple **astigmatism is corrected** by a cylindrical lens, while compound astigmatism requires a combination of two kinds. Success in treating astigmatism lies in removing the difference between the two meridians by a cylindrical lens appropriate to such difference; the spherical lens equaling the ametropia still remaining will then enable the rays of light to impinge sharply on the retina, and the anomaly will be corrected. A little reflection will show that it is sometimes a question of judgment as to whether it is better to correct the anomaly as apparent, or by a suitable cylindrical lens, create the opposite one, and then relieve that by its suitable lens. Success will be easiest attained by bringing up the best meridian to normal with a spherical lens; then allowing this glass to remain in the trial frame, take opposite lines, holding the axis of the cylindrical glass now used in the direction of these lines, and bring up the remaining meridian to normal.

Changes take place in the eye as age comes on, the practical results of which are, decrease in the refraction of the eye and shortening of the range of the accommodation. The recession of the near point beyond eight inches in emmetropic eyes may be regarded as the beginning of **presbyopia.** By means of convex lenses, the near point is restored to its normal distance and the overtasked accommodation relieved. In uncomplicated presbyopia, the patient can generally read No. 20 of the test-types at twenty feet, but he cannot see small objects well. Ordinary fine print cannot be distinguished at the former distance of eight inches and less, but it must be carried

farther from the eye. The accommodation is at fault, and rays from near objects are not focused upon the retina.

In the beginning of presbyopia, when the near point has not receded beyond nine or ten inches, very weak convex lenses will supply the deficiency in the accommodation, and will need to be worn only in the evening and by artificial light. If the near point has receded to nine inches, and it is desired to restore it to its original distance of eight inches or less, the lens necessary to do this may be found as follows: 1-8—1-9=1-72, which shows that a lens of 72 inches focal length, about a plus .5 dipotry, is required to supply the deficiency in accommodation. If the near point is at twelve inches, then 1-8—1-12=1-24. If the near point is at sixteen inches, then 1-8—1-16=1-16, and so on: or in other words, a 24 inches convex lens (about a plus 1.5 dioptries), will supply the first case, and a sixteen inches convex lens (about a plus 2.5 dioptries) will supply the second. The weakest convex lenses which will enable a patient without fatigue to read No. 1 of Snellen's test-types at from twelve to sixteen inches from the eye, are the correct ones. In the greatest number of cases, plus 36 to plus 40 will be quite strong enough in the beginning; an increased power will be required as age comes on. In some cases it will be better to begin with the weaker ones.

If in addition to the presbyopia, the patient is amblyopic, lenses will not improve the vision much, if at all. The perceptive power of the retina diminishes as age increases, at times causing a defect in the visual apparatus which lenses cannot remedy. The patient should have abundant aid. Many endeavor to conceal the full degree of presbyopia through false motives of pride, hoping thus to retain a baseless reputation for juvenility. Myopes may often weaken their concave glasses or lay them aside altogether when presbyopia supervenes. Cataract and glaucoma may find their cause in the strain put upon aged eyes by improperly fitting lenses. A rapid increase of this trouble is one of the premonitory symptoms of glaucoma; hence in fitting lenses, glaucomatous symptoms should not be overlooked.

The general principles on which to treat presbyopia are to recognize it early, and to supply abundant optical aid. If the lenses prescribed fail to relieve, a careful consideration of the convergent muscles must be made.

THE OTIC DISEASES.

SECTION ONE.

In all ear diseases open to **ocular examination,** it is essential to have a clear view of the innermost parts of the auditory canal. To obtain this it is necessary to place the patient in a position favorable to receiving a good reflected light. Daylight is better than artificial light, but it is desirable to be able to use either.

Having placed the patient in such position, then, an otoscope should be taken in the right hand, and, sitting or standing, the edge placed against the forehead to steady the instrument, and the concentrated light turned directly into the canal.

The otoscope consists of a concave mirror of about three inches focal distance. Its use is greatly facilitated by a head band to hold it on the forehead, freeing the hand for other purposes.

The outer portions of the auricle may be quickly examined, a speculum taken between the thumb and forefinger of the left hand, the upper and outer portion of the auricle seized with the disengaged fingers of the same hand and gently lifted upward and backward, straightening the canal. The speculum then should be introduced, and gradually pushed inward, as successive portions of the canal are viewed until the drum-head (membrana tympani) is clearly exposed.

The form of speculum now in general use is made preferably of hard rubber or german silver. Too much stress is often laid upon its shape; any one of them is suitable.

A **cotton-holder** consisting of a simple flexible wire, with a serrated end, with which to use absorbent cotton as a swab, is a valuable adjunct.

It is much to be regretted that there is no efficient way of testing and recording the hearing power artificially. The reason of this lies in the fact that but one way exists—by the human voice—and as that is not possible of successful imitation, many attempts have been made to utilize the ticking of the watch. With this the hearing power may be recorded as a fraction, the numerator of which is the distance at

which the ticking is heard, the denominator the distance at which it should be heard by an ear of good average hearing power. This denominator must vary according to the watch used, and should generally be expressed in inches.

Among the methods of diagnosticating and treating ear disease, there are none which are so constantly the subject of misuse as the various **methods of inflating** the middle portion of the ear. Nearly all cases of ear disease are subjected to some one or more of the different ways, and the ear "blown out," without much seeming regard to the ultimate results. Much damage is thus done, until it has been questioned whether there is not more damage than benefit produced by any of the methods known.

That of Politzer is the best and the one most often abused. It is based on two well-known anatomical facts; that the pharyngeal orifices of the Eustachian tubes open, while the uvula rests upon the pharyngeal wall during the process of swallowing, thus separating the upper from the lower pharyngeal space. In order to make use of this method, the patient takes a little water into his mouth, which is swallowed at a given signal. At this moment air is blown from a rubber bag-syringe into the upper pharyngeal space through the nostrils, and thence into the opened mouths of the tubes, and through the latter into the tympanic cavity, thus freeing those parts from obstruction or proving their permeability. Frequently this method will be sufficient for the purpose, but oftentimes a resort must be had to other devices.

As auxiliary to the method thus described and the catheter, it was proposed to auscultate these parts at the moment of their inflation by means of an instrument called a **diagnostic tube.** This consists of a flexible rubber tube, about two or three feet long, suitably tipped at both ends so as tightly to fit the external ear. One end is placed in the surgeon's ear and the other in the patient's. On forcing the air into the upper pharyngeal space as described, the surgeon listens to the sounds produced, and from them judges of the condition of the parts. At first much importance was attached to the sounds so heard, and a compendium of them arranged similar to that for exploration of the thorax, showing what might be diagnosticated from a "dry sound," a "crackling sound," etc., which was extended largely; but practice has shown them to be often wrong. In consequence this instrument has not proven as useful as was anticipated, though still used within its range.

That of Valsalva has a limited range, and is but little used. It

consists of simply holding the nostrils tightly closed with the thumb and finger, and making forcible attempts at expiration. It has become well known to the laity, and many cases coming to the aurist have "blown themselves up" so frequently as to seriously injure, and prejudice their chances of recovery.

Valuable practical information may also often be obtained in connection with inflation, by watching the **cone of light** on the drum-head. This method takes advantage of the fact that in its normal position a cone of light is formed on the drum-head, which changes into a square, divided or irregular shape with altered position, whenever the curvature of the membrane is changed. The latter being largely under the control of pathological changes within, this method becomes a valuable diagnostic aid.

But when these methods are not sufficient, a resort to other ways must be had. There is a tube leading directly from the pharnyx into the tympanic cavity. Desiring to reach this cavity with atmospheric air, and the methods mentioned having proved insufficient, the simplest way is to prolong this tube, by artificial means, from its opening into the pharnyx to an accessible point outside the head. The tube once so prolonged — that is, the **Eustachian catheter** passed, there is attached directly to the appropriately made and exposed end such apparatus as may be necessary to introduce the air.

Two ways have been suggested of prolonging this tube, one by passing a catheter through the nostril and inserting the distal end in the mouth of the tube, leaving the other end without the nostril; the other by passing the catheter through the mouth, and in substantially the same manner accomplishing a like result. The former only is used.

Familiar with the anatomy and possessed of a steady hand, it is a very simple matter to introduce the instrument. In a healthy condition of the parts it always should, and, if properly done, always will be painless, though oftentimes somewhat distasteful. But sometimes the inroads of disease have so affected the membrane, and produced such pathological changes, that some pain will result. When once in position, however, it should occasion little inconvenience.

Hard rubber catheters are necessary for steam or hot medication; german silver ones may be used at other times if preferred. The proper one having been selected, pour hot water over and through it, and let the patient blow the nose and be seated.

Holding the catheter perpendicularly with the thumb and forefinger

of the right hand near its funnel-shaped end, the ring on the instrument pointing to the mesial line of the body, slightly draw down the upper lip of the patient with the forefinger of the left hand, and introduce the catheter into the nostril. This being done, at once turn the instrument into a nearly horizontal position, with its concavity downward.

If it does not enter readily slightly withdraw the catheter, turn it a little, and on again advancing it will enter. Gradually raising it until it is in a completely horizontal position, urge it onward until it touches the posterior wall of the pharnyx. Then raise the funnel-shaped end, withdraw a little, generally from three-eighths to half an inch, and turn the catheter from within outward (guiding by the ring near the exposed end of the catheter) about one-quarter of a circle, or ninety degrees. This movement will lift the beak of the catheter into the mouth of the Eustachian tube if the catheter has been withdrawn exactly enough. Sometimes it will be found that the instrument seems to engage the mouth of the tube, and yet does not open into the tube. In such case it has not been withdrawn enough, and, in consequence, the beak has been lifted into the pit just behind the mouth of the tube. Once in position it is grasped tightly by the muscles, and the Eustachian tube is prolonged as desired, and there is a continuous channel from the funnel-shaped end of the catheter through it into the Eustachian tube and thence into the tympanic cavity of the middle ear. Proof of this is made by blowing a little air into the tympanic cavity with the bag-syringe, using a moderate degree of force only.

There are a few accidents liable to occur: Laceration of the membrane is the most serious, as on inflation by any method, emphysema of the submucous tissue may result, and be accompanied by serious symptoms; the mouth of the Eustachian tube may be missed, and the cicatrix of some old ulcer, or an ulcer itself, engaged; some hemorrhage may result from rough manipulation.

But the first and third will not happen with careful manipulation, and the second can be avoided by a **pharyngeo-rhinoscopic examination,** which should always be made whenever there is occasion to suspect any old cicatrix, any existing ulcer, or any disease involving extensive or deep-seated pathological changes.

With the catheter successfully in place, it will develop a very unpleasant tendency to slip out. Numerous bands, clasps, etc., have been devised to retain it, but it is better controlled by a gentle touch.

It may be unnecessary to force any air through the catheter, the simple introduction and consequent opening of the mouths of the

tubes, being all that is necessary. But some diseases of these parts will require the use of air as a preliminary step if it does not suffice for the entire treatment.

One advantage of the simple introduction of the catheter is that in many cases where it could not be previously used advantageously, after the mouths of the tubes have been simply opened, Politzer's manner of inflation can be successfully used.

The various **ways of using air** are:

By the rubber air-syringe. The nozzle of the air-syringe should be supplied with a rubber tube about eighteen iuches long, tipped with a nozzle to fit into the catheter, and the bag-syringe should be made with a valve allowing immediate inflation after an expiration, thus rendering unnecessary the removal of the nozzle from the catheter until the operation is completed. With such arrangements the syringe can be freely compressed without jarring the catheter in the least.

By means of a condensing pump and metallic receiver. This apparatus consists of a large metal reservoir, into which for some minutes air is condensed by a pump. To this is attached a flexible tube from which the air is shut off by a valve. When it is desired to remove some obstruction or adhesion, the tube is attached to the catheter and the compressed air turned on.

By attaching the pump to a tube connecting with the catheter and forcing air directly into it.

Quite a number of **accidents** have resulted from the last two ways. A glance at the anatomy of the middle and internal ears shows that in the tympanic cavity are the three ossicles of the ear, one of which is attached to the drum-head; one presses against the oval window (fenestrum ovalis) in such a manner that it will compress the contents of the unyielding bony walls of the labyrinth and squeeze the delicate filaments of the auditory nerve (the third forming the connection between the other two); that the mastoid cells open directly into the tympanic cavity; that the delicate drum-head forms the only barrier between this cavity and the external ear; and that all these, as well as other delicate parts of the auditory apparatus, are exposed to the shock of a blast of air driven through the catheter. It is clear, therefore, that no operator should in any manner force air into the tympanic cavity with unyielding power; and it is reasonable to believe that any so doing will have accidents of a serious nature.

Pharyngeal disease is so closely allied to otic disease that the former must be suspected as the cause of much trouble in the ear.

SECTION TWO.

All descriptions of **foreign bodies** are found in the **external auditory canal,** such as pins and needles, beans, peas, etc. They are usually quickly removed by thorough syringing, but much damage may result from blindly probing.

It should be an imperative rule never to do anything until a thorough inspection with an otoscope has been made. Proper, patient syringing will remove almost every kind of body. When instruments are necessary, cautiously dislodge the body and syringe it out.

The auditory canal is frequently the seat of a class of **parasites** which materially aggravate or cause inflammations of the part. Most commonly they are secondary to eczema. They can be distinctively seen only by the microscope. The symptoms are a sensation of fullness, deafness, vertigo, heavy dull pain, blackish or whitish flakes blocking up the canal and adhering to its walls.

The treatment consists in removing all traces of them and subduing the inflammation. The forceps and hot water usually meet these indications.

The auricle is the seat of few troubles not associated with the canal, or other adjacent parts. Frost-bites are common; after extracting the frost, exclude the air by emollient cerates or collodion. Diffuse inflammation and abscesses should be carefully treated, as they are liable to produce great deformity.

Psoriasis, ichthyosis, comedo, acne, and other dermatological, as well as syphilitic diseases, attack the auricle, but malformations and malignant diseases are rare. Deposits of urate of soda are often noticed in gouty subjects, and may cause some pain.

Inspissated Cerumen, or dried and hardened ear-wax, is frequently found in the auditory canal, and should be removed on the same principle as any other foreign body. Its presence must be regarded as a symptom of disease, and its removal but the precursor of other treatment.

The symptoms of its presence are ringing in the ears, deafness, sense of fullness, more or less pain, and in the severest forms, reeling and staggering. It is easily seen with the otoscope.

It may not be advisable to remove it all at one operation, unless small in amount and easily loosened. When intensely hard, as it often

is, some solvent (glycerine and oils are useless), such as ten to twelve grains bicarbonate of soda to an ounce of hot water, may be instilled several times shortly before its removal is attempted. No force should ever be used to wrench out this substance, as the canal is too delicate to bear violent treatment. After all is removed, a little cotton to deaden the shock of the now increased sounds may be used.

A good **artificial membrana tympani** can often be worn, greatly improving the hearing when a cure can not be effected, hence there have been placed upon the market numerous forms of worthless appliances recommended as substitutes for or adjuvants to the normal membrane.

It is not necessary that the natural membrane should be gone, or nearly so; often an artificial membrane, well placed, will restore hearing when the natural membrane is almost or quite intact. But little can be written on the application of these aids to hearing, their beneficial use almost entirely depending upon the kind selected, its practical application, etc. Simple as it would appear, it is a matter of tact. It may be said in general, however, that it should be applied only to the end and one side of the passage, well down to the opening, if there is one, and not covering the external part of the drum, but leaving a small opening.

Furuncles within the auditory canal are usually troublesome. When seated either in a hair follicle or ceruminous gland, the furuncle has in its center a circumscribed core which must be discharged before resolution takes place. But if seated where the swollen, inflamed connective tissue can not extend itself, as upon bone, the symptoms of tension will be much more severe. The pain will therefore be much greater in the latter than in the former case. In mild cases it is of a burning, sticking or itching character. In all cases it is accompanied by more or less systemic disturbance, such as fever, sleeplessness and loss of appetite. The auditory canal becomes excessively tender, an examination becomes a great dread, a slight touching with a probe causing great pain. The swelling is not always well marked, and on account of the closing of the canal it is difficult to find the exact seat. One may recover to be succeeded by another and another, or so great a number of small ones as to constitute a **furuncular rash.**

Hepar sulphur, or silica, will often effect a cure, but if the furuncles continue troublesome, fill the auditory canal hourly with a solution of one part of alumina acetate to four parts of water. If they are large and well marked, incise them promptly and use hot water to

promote suppuration. If not well marked, find the most tender point and incise that. There is no harm from the free bleeding which may result.

The acute form of **eczema** about the ear generally begins with more or less systemic disturbance, and the formation of vesicles upon the auricle and within the canal. These soon burst with a discharge of thin serous fluid, which spreads over the skin and dries there, forming crusts or scales. The bursted vesicles form scabs, which if peeled off expose a red surface. The denuded skin under these vesicles ulcerates and pus forms. If a cloth is applied to the discharge from the vesicles, it soon becomes stiff, the discharge drying rapidly. The effusion being always considerable, the auricle becomes swollen and stiff, cracks, and fissures, and the swelling of the canal causes some tinnitus and deafness. The itching and burning are most annoying, but if the vesicles are scratched or torn the trouble is only increased.

In the chronic form the febrile symptoms and local swelling, itching and burning subside, the vesicles collapse, and dry scabs or crusts take their place. Underneath the scabs will be found considerable pus. The skin is no longer moist, but dry and rough. It is a troublesome affection, but gets well under patient treatment, and good hygienic conditions. When the chronic form is present, consequent on the cessation of menstrual life, taking the place of the usual headaches, it is often exceedingly annoying and obstinate.

Local applications are very uncertain in their results. The dusting on of powdered starch will often be efficacious. Glycerine relieves some and aggravates other cases. When vaseline is well borne, it may be medicated with the appropriate remedy.

The best internal remedies are apis, arsenicum, croton tiglium, graphites, mercurius, pulsatilla, silica, sulphur and tellurium.

SECTION THREE.

A large proportion of all ear diseases which the practitioner is called upon to treat, is due to some form of aural **catarrh.**

Two forms are well recognized, the acute and the chronic. Both are characterized by a tendency of the originial tissues to harden and stiffen, thus forming a marked contrast to suppuration of the middle ear.

Acute catarrh is an inflammation which causes a secretion of mucus but stops short of the production of pus. Absorption takes place, or the secretion is expelled through the Eustachian tubes.

The principal causes are colds in the head, the exanthematous diseases, the continued fevers, and exposure to wet and cold in any form.

Its symptoms are marked, and are embraced under a sensation of fullness in the ear; hardness of hearing; noises in the ear which are often very annoying; pain, worse at night, when delirium may set in; vertigo, and sometimes nausea; general fever; catarrh of the pharynx; anxious expression of the countenance and great restlessness. The drum-head is swollen and injected.

These symptoms are those of the heaviest form. A light form also attacks, and is very insidious in its course. It generally affects only one, but may affect both ears. It has no pain, causes little deafness, but produces an uncomfortable stuffiness of the ears, and usually slight tinnitus. The drum-head shows only the slightest if any change. The patient usually gives slight attention to it, and it goes away in a few days, often to return again and again until it becomes securely seated.

In its severer forms this disease may easily be mistaken for cerebritis or meningitis. The inflammation generally starts from the pharyngeal end of the tube, but this may be reversed. The pain is not generally so severe as in the acute suppurative form, and being of a darting nature and not especially limited to the ear, is often mistaken for neuralgia. It is increased by talking, coughing, sneezing, etc., and often forms the chief complaint. Alteration in the tone of the voice, subjective sounds, etc., may, and usually do, accompany the trouble.

Scarlet fever especially, of the exanthematous diseases, shows the greatest tendency to implicate the middle ear (though the result is generally of the suppurative form). To avoid mistakes, either in diagnosis or treatment, the ears of all patients with this disease should be examined. The "earache" of childhood is identical with the milder forms of this disease.

For local treatment, in the early stages, the best is a prompt application of the hottest water that can be borne, constantly increasing its heat as it can be tolerated. The aural douche is useful for this, or a bag-syringe, the bag being hung up at a sufficient height to give the requisite gentle force. A few drops of a two- to five-grain solution of atropia sulphate, or of cocaine, may be dropped into the ear provided the drum-head is imperforate, and will quickly in combination with

hot water relieve the worst pain. Children only require a solution of one half the strength. Inflation of the tympanic cavity with Politzer's apparatus, or otherwise, is necessary to let out the secretions; or if much is secreted, or inflation impracticable, a paracentesis of the drum-head should be at once performed and repeated as often as essential. If the attack is mild, inflation and remedies will control it.

Particular injuctions should be laid to keep the patient from stuffing the ear with oils, molasses, or other troublesome foreign bodies. If the mastoid region becomes involved, a free incision should be made as is explained under mastoid symptoms. Poultices to the internal parts are dangerous, and should not be used, it being almost impossible to limit their effect.

The great object of the treatment is to prevent suppuration, but when once suppuration has set in, the case has become one of the suppurative form, and must be treated accordingly.

Those cases which have passed the acute stage are known under the various names of **sclerosis of the tympanum, proliferous inflammation,** progressive hardness of hearing, etc.

The exciting cause may often be found in the acute form. But the underlying cause is found in a feeble state of the system, heredity, acquired or inherited syphilis, phthisis, defective hygienic care, as want of proper exercise, food, etc. Chronic catarrh of the throat, repeated attacks of acute catarrh of the middle part of the ear, diphtheria and scarlet fever, are common causes, and it is inseparable from certain climates, especially after an exhausting illness.

The symptoms, more or less of which are present, are a sense of fulness in the ear; deafness; vertigo often; a sensation of air-bubbles breaking and cracking in the ear; noises of varying sounds, of which great complaint is usually made; imperfect action and changes in the Eustachian tubes; chronic naso-pharyngeal catarrh; changes in the drum-head, such as alteration in position and shape of the cone of light, deposits, sinking and atrophy. The ear-wax diminishes in secreting; it then becomes brittle, and later on fails altogether.

The earliest subjective symptoms are generally noises and growing hardness of hearing, which usually come on suddenly, and oftenest affect the left ear first, and then may pass to the companion ear. Sharp twinges of pain are felt every day or two. All the subjective symptoms are intensified by fatigue, prolonged conversation or nervous exhaustion of any kind. But nearly all, except the growing hardness of hearing may be wanting in the severest cases of the proliferating form.

The disease is very tedious in its course; often quite as much so in its cure. The many names given it more or less note some of the changes, and indicate a wide variance and incomplete knowledge of its pathology. The noises in the ear are frequently most distressing. There is no special sound indicative of special lesions, and each patient is most likely to associate some familiar sounds with them. In common with the appearances of the drum-head, they have been made the subjects of exhaustive study.

Two classes seem however to be well marked, the **moist** and the **dry,** and materially affect the prognosis, the former being far more amenable to treatment than the latter. In the former, under suitable medication and local treatment, a more or less satisfactory restoration of hearing and cure may be foretold; in the latter, in the hypertrophied stage the prognosis is unfavorable; in the atrophied stage hopeless. Proliferating bands are often thrown out, quite like spider-webs, and tie down with firm grasp the delicate structures. A peculiar odor, doubtless due to the altered secretion of the buccal glands, well simulated by moistening the finger with saliva and allowing it to slowly evaporate, may be noticed about the breath of the majority, and is most marked in the female. Relapses are very common and should not discourage.

For convenience in treating of the subject, and the more properly to describe a large number of cases, a class lying in the tract between the acute and chronic forms, are called **subacute.** They are such cases as have passed through the acute and linger on the border of the chronic form. There is no special line of demarcation, but such cases yield under less treatment, though were time of existence the only element, they would justly be classed as chronic.

The incomplete knowledge of the pathology, the inaccessible position of the parts to be treated, and the often vacillating mind of the patient, alike combine to render the treatment the most unsatisfactory of aural practice. A hap-hazard, empirical plan of trying this and that in the expectant hope of relief, has nearly always been pursued ere the patient comes under scientific treatment; and even then floating memories of old-time necromantical cures are liable to tempt the patient away. The injudicious determination of those who suffer with acute affections "not to tamper with the matter, but let it wear off" places hundreds on the list of incurable.

Tinnitus aurium, or ringing in the ear, is a more or less constant symptom of most forms of ear disease, and oftentimes lingers to the torment of the patient after all apparent disease has passed away.

These **noises** are the result of nearly every kind of irritation of the auditory nerve, either in its course from the brain, or its final distribution in the labyrinth. Any change of the normal pressure of the labyrinthine fluid, as when the stapes is pressed in or drawn outward, produces noises in the ear varying in direct proportion to the force exerted. It is impossible, with some general exceptions, to tell from the nature of the noises where the cause is, for the pressure sufficient to produce these noises may be occasioned by a collection of fluid, or a swelling of the lining of the tympanic cavity; by all obstructions of the Eustachian tubes sufficient to interfere with the ventilation of the tympanic cavity; by the exclusion, by obstruction from any cause, of the air from the external meatus, etc. These noises, too, are generally likened to some sounds with which the patient is associated or familiar, thus not infrequently removing the only guides there might be.

Crackling noises are caused by air passing through the mucus in the tympanum in the moist stages of chronic catarrh, suppuration, etc. Now and again a patient will be found who can voluntarily produce such noises in the ear. Pulsating noises are heard when from any cause there is an interference with the arterial circulation. In cases of aneurism these sometimes become so loud as to cause deafness.

A changed condition of the blood, as in anæmia and chlorosis, produces tinnitus similar to the venous blowing heard in chlorotic females. All labyrinthine diseases, and often blows on the head and violent concussions from any cause, are productive of noises in the ear.

The treatment is a matter for careful consideration in individual cases. No class of ear troubles has so long resisted the remedies proposed for its relief. The pharynx and nose should engage attention at the outset, and all complications there removed and kept down. A persistent endeavor to soften the dry or parchment-like membrane of the Eustachian tubes and tympanic cavities by internal remedies, accomplishes as much as the usually applied local treatment, and does less harm. The effects of the constant current of **electricity** are sometimes surprising if persisted in, but usually disappointing. Inhalations, inflations and injections usually accomplish no permanent benefit, but are useful if at all, in the order named. Perforation (**paracentesis**) **of the drum-head,** or division of the muscle controlling the tension of this membrane, are tried in the worst cases, and sometimes prove beneficial.

In the early stages there is no better remedy than aconite. When there is a high febrile excitement, with acute pains running along the Eustachian tubes to the ear; sharp pains suddenly in the ear; dryness

and burning in the throat; it is fully indicated. Severer symptoms, such as fullness in the ear; deafness and vertigo, with violent pain in the ear and over the whole side of the head, also call for this remedy.

Apis mellifica is most useful when there are stinging, burning pains, with intense itching. Inflammations following eruptive diseases are also well met.

Arsenicum album is indicated when there is great prostration and irritability following or accompanying these troubles. The pains are periodical, and there is chilliness and shuddering, attended by humming in the ears and loss of hearing.

Baryta iodata is highly useful in chronic thickening of the mucous membrane, and to reduce enlarged tonsils.

Belladonna is called for when there is local congestion, manifested by throbbing pains, cerebral excitement, or delirium, wild expression of the eyes, with intense pain.

Cantharis is valuable in the dull, heavy, and extremely sore throat often accompanying these troubles.

Causticum is valuable in the proliferating form. Paralysis is relieved by it.

Hepar sulphuris is very useful in promoting resolution when suppuration is immediately threatening. It arrests and cures ulceration of the tympanic membrane. Abscesses are speedily cured by its administration.

Kali iodatum has a beneficial action on thickened mucous membranes.

Mercurius is one of the best of internal remedies, having a pronounced action on the thickened mucous membrane. Sharp, stinging pains extend into the ears. Pain abates toward morning. Perspiration profuse, but not relieving. It is especially valuable in the proliferous form of middle ear disease. Hardness of hearing due to swollen tonsils, and when due to obscure troubles, or syphilitic origin is well met by this remedy.

Pulsatilla is a valuable remedy in catarrhal affections of the Eustachian tubes.

Acute suppuration is an inflammation which quickly passes over the mucus stage and hurries on to purulent inflammation. It is characterized by a tendency to break down and destroy the original tissues. It has two forms, acute and chronic. Unlike acute catarrh, it is almost never insidious in its attacks, but bold and pronounced.

The main causes are often a direct result of a somewhat prolonged acute catarrh; the suppurative form is always preceded by the ca-

tarrhal, though in many cases the latter is overlooked and the discharge of pus is the first thing noticed.

In severe cases the symptoms are rapid and violent. All the symptoms of acute catarrh are present, but greatly intensified as a rule. The pain is intense, causing great suffering, and is generally referred directly to the ear, though extending to the eye and temple, and backward to the occiput. General fever and tendency to delirium are usually marked. There is great liability to confounding the disease with brain trouble. The drum-head bulges out, is swollen and injected, and not infrequently colored yellow from the pus behind.

Diagnostic points will be found in the fact that any given quantity of mucus in the tympanic cavity will not cause the amount of bulging out of the drum-head that a like quantity of pus will. This bulging is usually confined to the posterior half of this membrane. The pain is usually much more intense than under the catarrhal form, and is accompanied by a general systemic disturbance. With all this, however, the auricle and meatus may be quite insensible to gentle traction, freeing all suspicions of external otitis as the cause of the pain.

The tympanum in such attacks is practically a shut cavity, by reason of the closure of the Eustachian tube, and confines a raging abscess. On account of the close proximity of the cranial cavity and its contents, and its intimate connection with the tympanic cavity, the life of the patient is often greatly endangered. Prompt treatment is sometimes necessary to save life, and saves months of after-treatment in the event of recovery.

In general, swelling in front of the auricle is usually of little moment; behind the auricle it commands attention. In case the mastoid region becomes involved it should be treated on the principles laid down hereafter.

The tendency of this disease is to destroy the drum-head and sweep away the contents of the tympanic cavity. Such results are to be carefully guarded against, as destructive of hearing. If it passes into a chronic form, the treatment is tedious and more or less unsatisfactory.

For local treatment, the congestion and pain are to be reduced as quickly as possible. Hot water used as indicated under acute catarrh, will do this, though great relief to the pain will be derived from putting a few drops of a two- to five-grain solution of atropia sulphate, or of cocaine, in the ear, which may be safely done provided perforation of the membrane has not taken place. The tendency to poisoning by the solution running directly into the pharynx must not be forgotten.

Children only require a solution of one-half the strength. A paracentesis should be done early; if any pus has formed, it lets it out; if none has formed, the relief to the pain is very grateful, and renders a knowledge of the condition of the tympanic cavity certain. All forms of continued poulticing are to be avoided. General treatment must be directed to relieving the pain and producing sleep. Special attention should be given to the free action of the skin.

Otorrhœa, or **chronic suppuration,** is the bane of the laity, and sufferers are warned to do nothing, being told the discharge is innocuous or beneficial, and that a stoppage would be injurious. On the contrary, though death is not an infrequent result of neglected otorrhœa, no harm ever comes from properly stopping a foul discharge; improperly stopped or corked up, under the impression that when not seen the suppuration no longer exists, great harm might be done.

The chief causes of chronic suppuration are an acute inflammation of the tympanic cavity and surrounding parts, and disease of the bones. Diphtheria, and scarlet fever especially, add largely to the most severe cases.

The symptoms are deafness, with a purulent discharge of an offensive odor from the tympanic cavity into, and often out of, the external auditory canal. The pus being cleansed away, there may be seen a perforation of the drum-head, most frequently in the posterior inferior portion, though it may be anywhere, and varying in size from a pin-hole to two-thirds of the membrane. A drop of pus is often adhering in the perforation, and pulsates synchronously with the heart's action. The external meatus and the outer surface of the drum-head have a bright-red appearance due to the constant bath of pus. More or less pus secreted from the walls of the external meatus is also present. The general health is frequently below the normal standard, and the pharynx will be found in a catarrhal state.

In any form of treatment, there can be no success without absolute cleanliness of the tympanic cavity and the external meatus. The anatomical relations are such that the foul discharge remains a source of constant irritation and self-perpetuation, instead of flowing away. The ear should be appropriately syringed out as often as is necessary to keep it clean, and from five to twenty drops of a ten per cent. solution of carbolic acid to a pint of hot water, will be found an excellent solution for this purpose. A two to four-ounce hard-rubber aural syringe should be obtained, the hot solution prepared, and the cavities thoroughly cleansed. Care is requisite that the patient does not take cold after such treatment. Some cases do better when the canal is

cleansed with absorbent cotton. This may be used on a cotton-holder and the canal carefully mopped out under a full light from the otoscope. Politzer's bag, or other means of inflation should be practiced. Local treatment oftener fails to do good from carelessness and inattention of the attendant or patient, than from any other cause. Patience and perseverance are rewarded by success.

Caustics, astringents, etc., may be employed, but are liable to do damage. They are useless unless strong, and in the same ratio the more dangerous. In a certain number of old, neglected chronic cases their proper use will greatly accelerate the cure. Nitrate of silver, compound nitrate of silver, and sulphate of copper are the most reliable, and may be used in varying strengths. Boracic acid on cotton moistened with cosmoline, or applied with a blower, is useful. All preparations should be applied on a thoroughly cleansed surface.

Much discussion has taken place on the best form of treatment, wet or dry, but individual cases demand each, and neither is always alone successful.

Polypi are a very frequent result of neglected suppuration. Though sometimes liable to be confounded with malignant growths their diagnosis is generally easy.

They usually consist of loose connective tissue, cells and blood-vessels, partaking of the nature of fungous granulations, and grow most commonly from the tympanic mucous membrane, more rarely from the surface of the inner half of the external canal. Of a bright red color, usually granulated like a strawberry, though sometimes smooth, they vary in size from a pin-head to a long tortuous body, closing entirely the external canal or appearing beyond the external orifice. They may be attached by a more or less narrow peduncle (**pedunculated**) or sit upon a foundation approximative to their size (**sessile**). Soft and excessively tender, they bleed on slight contact, and constantly bathed in pus, are offensive in odor. Their spongy nature, soft and pliable, often makes the mechanical obstruction of the canal and consequent retention of the pus a source of great danger.

Local treatment consists in removal by any instrument best suited to the position in which they are found. This results in a permanent cure, slight after-treatment being only necessary. A wire ensnaring the growth and heated by electricity quickly removes, and by the application of the resultant actual cautery restrains the profuse hemorrhage. A minute drop of acid (chromic, nitric, mono-chloro-acetic, or carbolic), will often be sufficient for those of small size. A satu-

rated solution of bichromate of potash directly applied will sometimes be effectual, and is painless.

When from any cause the suppuration is suppressed, what are known as **mastoid symptoms** may supervene. **Periostitis** is the most common mastoid complication, and is apparent by tenderness on pressure over the mastoid region of the temporal bone. In case of involvment there will be in addition to the tenderness (which is often extreme) swelling, redness, and pain, the latter frequently violent. But redness and swelling are not infrequently present in the mastoid region in connection with aural disease, and require no local treatment.

In this periostitis local treatment is absolutely necessary and should be prompt. A free incision over the mastoid process down to the bone should be made, and poultices applied. If the incision be made parallel to and about one-quarter of an inch behind the auricle, about one-half of an inch to an inch in length, and care be taken to cut upward, the operation is a simple affair. In the early stages no pus will be found, but the relief to the tension, so important in periostitis, will be most grateful. In latter stages, suppuration may be profuse and of a foul odor.

Caries and Necrosis are consequences of extension of the inflammation just described, and require the surgical treatment usually given these troubles when occurring elsewhere. In the severest cases **cerebral abscess** is not an uncommon result, but often masked in its symptoms. Nausea and vomiting, or a chill usually precede fatal symptoms. But in exceptional cases long, tedious brain troubles result, though paralysis, coma and death more frequently.

Arsenicum iodatum is useful in profuse, ichorous discharges accompanied by great prostration.

Asafœtida meets purulent discharges, with diminished hearing, after the abuse of mercury.

Aurum metallicum is particularly valuable in troubles of syphilitic origin, when there are thickening of the membranes and swollen cervical glands, worse on touch. The tissues of the external meatus are bathed in a fetid pus, the odor being characteristic of necrosed bone. It is also valuable in fistulous openings and sinuses in the mastoid process, and in caries of the mastoid process and ossicles.

Calcarea carbonica is one of the most useful remedies in these diseases. It meets polypi associated with purulent discharge; scrofulous affections of the bones; thickening of the drum-head, and inflammatory swelling of the parotid glands. Patients with large abdomen

and warts on the hands, scrofulous subjects, fat, rapidly-growing, large-headed, soft-boned children, especially demand this remedy.

Cantharis is particularly suited to chronic inflammation of the Eustachian tube and tympanic cavity, and accompanying low grades of inflammation in the external auditory canal.

Capsicum is indicated in redness and swelling over the mastoid region. There are itching and pressure deep in the ear. It is also valuable for acute symptoms in chronic cases, the mastoid cells becoming involved.

Carbo vegetabilis is useful in mechanical obstruction to the Eustachian tubes from swelling of the tonsils.

In mercurius the discharges are thin and acrid, the ears, teeth and face ache, and all symptoms are worse at night. The ear troubles are accompanied by a vesicular eruption on the face and lower limbs.

Mezereum finds a sphere of action in chronic ear complaints associated with syphilis.

The pains in the bones of the skull are increased by touch, and worse at night.

Nitric acid is useful in caries of the mastoid process. It is also especially useful after the abuse of mercury, and in diseases of the ear following syphilis.

Pulsatilla nigricans has a good action on mild, bland discharges in the characteristic subject.

Silica has a direct action on the middle layer of the membrana tympani. It promotes suppuration, and is invaluable in obscure ear troubles. Collections in the Eustachian tubes are relieved by it.

Sulphur meets purulent, offensive discharge, with eruptions on the face and body. Ear complaints from suppressed discharges and eruptions are relieved.

Tellurium is indicated by an offensive otorrhœa, smelling like fish-brine. The characteristic patient is almost the exact opposite of the pulsatilla subject, being angular and sharp.

SECTION FOUR.

Nervous deafness primarily is an exceedingly rare disease. Secondarily it is commoner, though it may be associated with some form of middle ear disease. Many cases of deafness are erroneously

attributed to this trouble when the real cause is hidden. There are no external signs or appearances of the tympanic membrane from which this trouble can be diagnosticated, but its presence is assured in the main by exclusion of all diseases of the external and middle parts of the ear from a careful examination, and an accurate knowledge of the values and peculiarities of the **tuning fork.** No theoretical course can be laid down, so that unless a practical familiarity with the fork is had, errors in diagnosis may be made.

The diagnosis of this class of diseases may be also confirmed by a consideration of the following items:

The history.—This may directly connect the defects of hearing with other nervous troubles. Care should be exercised, however, that the diagnosis is not misled by circumstances directly attributable to mechanical causes. The degree of deafness.—In this it is difficult to say at just what point, but a very excessive degree cannot depend on absence of conduction; in other words, the congenital absence of the conducting apparatus does not necessarily involve as low hearing power as the disease may produce. Certain peculiarities of hearing.—Hearing worse on attempting to listen, after excitement, fatigue or mental depression. A better hearing from some sounds than for others.

Cases of ear disease attended with loss of equilibrium accompanied by sudden deafness, should be known as **labyrinthine disease;** other symptoms such as nausea, vomiting, vertigo, and tinnitus aurium are also present. A number of these will be recognized as accompanying affections of the middle ear and cerebro-spinal meningitis.

There is another class of patients, however, which is often classed under this head of nervous deafness, but ought to be excluded and the term dropped as erroneous. This is, those patients who are weak, unsteady in muscular movement, debilitated in nervous tone, despondent, anxious and affected with a chronic disease of the ear. Nearly all such cases belong to those of the middle ear, and if impinging on the internal ear class, it is by extension to that portion of the ear, and not as the primary seat of disease. Persons who are debilitated, anxious and unsteady have not necessarily impairment of hearing, or any symptoms of derangement of the auditory nerve; and affections of the auditory nerve do not necessarily weaken, though they may cause unsteadiness of gait.

SECTION FIVE.

With rare exceptions, all deaf mutes are dumb because they cannot hear. With extremely rare exceptions there are no changes in the larnyx, except such as may come from disuse of that organ, and could mutes hear they would soon learn to speak. From this primary fact, then, it may be seen how important it is that the ear should be correctly understood.

There are two classes of deaf-mutism, congenital and acquired.

Infants are conscious of sounds at about the third month, of particular sounds, such as whistling, chirping, etc., at about the fourth month, but from the fourth to the sixth month is the earliest at which an opinion can be formed as to whether an infant is deaf or not. But inasmuch as most deaf mutes have a certain amount of hearing, they may be classed as those who can hear the human voice as sounds, but are unable to distinguish words, amounting to about one-tenth of the whole; those who can distinguish loud noises, such as clapping the hands, ringing of bells, thunder, cannon firing, etc., amounting to about five-tenths of the whole, and those who are completely deaf, numbering about four-tenths of the whole.

From many thousand cases examined, it has been deduced that the muscles are mobile which open and close the larnyx, and the vocal cords vibrate perfectly. The cords do not, however, correctly adapt, especially in the formation of vowels. Not infrequently a slight catarrh of the cords is also present, but all these are doubtless consequent on non-use, and would disappear on exercise of the proper functions.

Climate exercises a great effect in the production of mutism. Switzerland furnishes the greatest number; Belgium, the least. The various sections of England, even, vary greatly in the number of mutes found within their borders. As might be expected, a like dissimilarity is found in the various States of our Union.

Did mutes hear, they would learn to speak. It does not follow, however, that all who are deaf become mutes. If a patient becomes deaf during childhood, he will certainly become dumb; if during youth, he is apt to; but after he attains to years of discretion, it is exceedingly rare that the effects are so dire. Changes, however, gradually take place, and of a serious nature. The mental powers are apt to become

blunted, the mind works sluggishly. Of less moment, but still serious, are the changes of voice. Unable to hear themselves speak, they can not modulate their tones; hence it is common to hear a deaf person raise his voice almost to a shout in some confidential communication or sink to a whisper in a public address. For this reason, also, clergymen and public speakers are obliged to give up their occupation when serious impairment of hearing takes place.

The causes of deaf-mutism are to be found in the middle and internal parts of the ear, such as the results of the exanthematous diseases (prominent among which are scarlet fever and measles), brain diseases, falls, frights, etc.

The prognosis and treatment of these diseases, combined with the age of the patient, will be the foundation on which to base the prognosis and treatment of deaf-mutism. Only by a well-grounded and comprehensive knowledge of aural disease, combined with experience, can a proper opinion be founded. The principles of aural surgery, combined with the principles of general medicine, must be well considered. Here, as well as elsewhere, a too exclusive attempt at special and local treatment will bring failure instead of success.

Congenital deaf-mutism is incurable in the present state of our knowledge. The aid of surgery has been well tried by skillful surgeons, and some beneficial results obtained; but the standard of infirmity has only been raised; the patient has not been removed from the class.

The treatment of the deaf-mute may be divided into prophylactic, medical and instructive.

The prophylactic treatment should consist of the proper hygienic treatment, enforced sanitary regulations, such as isolation from all malarious influences, mental rest and cheerful company, warm and abundant clothing. There could be nothing better in this direction than agreeable and remunerative employment.

The medical treatment should consist of carefully meeting and warding off all unfavorable symptoms as they arise; and in every way encouraging and sustaining such hearing as is apparent or may become developed.

In each case all should be done which will tend to conserve the hearing power. When a discharge is present, the auditory canals should be kept clean, the bones protected from caries, and at least extended ulceration of the membrane prevented. The cause of any existing otorrhœa should be carefully sought out, removed and the chronic suppuration cured.

"The deaf mute who presents the most favorable conditions for treatment is he whose accidental deafness has supervened at the age at which he begins to hear and speak, and who still retains some faint evidence of hearing and speech. If the organic lesion, the first cause of the infirmity, be seated beyond the nerve centers; if the child be intelligent, and have no brother or sister in the same state as himself; if he be the child of healthy parents, who have no connection by consanguinity, and if he have never previously been under treatment, the chances of cure are numerous; but if all these conditions are met with in the same subject the chances almost reach to a certainty. On the contrary, they decrease in value in proportion as one or more of these conditions are wanting, and when all are wanting we should entertain scarcely any hope."

Among the means of keeping up such hearing as may be present, the ear-trumpet should be mentioned. Constant use often enables a little patient to become familiar with sounds, and render his wishes intelligible. To the older one it is often the only means left by which he can retain perception of tones. It is greatly to be regretted that a more convenient appliance of such general application as the trumpet has not been invented. Similar devices have but a limited usefulness, though in exceptional cases they act in a favorable manner.

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